REPORT ON GLUCOSE,

PREPARED BY

THE NATIONAL ACADEMY OF SCIENCES,

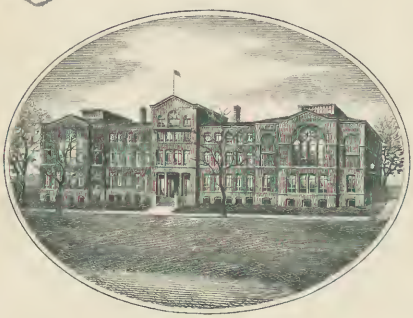
IN

RESPONSE TO A REQUEST

MADE BY

THE COMMISSIONER OF INTERNAL REVENUE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1884.



UNITED STATES INTERNAL REVENUE.

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TREASURY DEPARTMENT,
Document No. 535.
Internal Revenue.

CORRESPONDENCE.

YALE COLLEGE, NEW HAVEN, CONN., *January* 7, 1884.

SIR: I have the honor to transmit to you herewith a report on glucose, made by a committee of the National Academy of Sciences, in response to a request of your predecessor, Hon. G. B. Raum, dated April 27, 1882.

Very truly yours,

O. C. MARSH,
President National Academy of Sciences.

n. WALTER EVANS,
Commissioner of Internal Revenue.

PHILADELPHIA, *January* 5, 1884.

SIR: I have the honor to transmit to you herewith the report of the committee of the Academy appointed to investigate the "composition, nature, and properties of the article commercially known as glucose, or grape-sugar."

With high respect, I remain your obedient servant,

GEORGE F. BARKER,
Chairman.

Prof. O. C. MARSH,
President National Academy of Sciences.

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REPORT.

I.—GENERAL INTRODUCTION.

The present committee was appointed in accordance with a request contained in the following letter from the Hon. Green B. Raum, Commissioner of Internal Revenue of the United States:

TREASURY DEPARTMENT,
Office of Internal Revenue, Washington, April 27, 1882.

SIR: There is now pending before Congress a bill (H. R. 3170) "to tax and regulate the manufacture and sale of glucose," which bill proposes to so amend the internal-revenue laws as to impose a special tax upon the manufacturers of and dealers in glucose, and to levy a tax on the article in its solid, liquid, and semi-liquid form.

In view of this, I have respectfully to request the appointment of a committee of the Academy to examine as to the composition, nature, and properties of the article commercially known as "glucose," or "grape-sugar."

This office desires to be informed as to the saccharine quality of this product as compared with cane sugar or molasses, and also especially as to its deleterious effect when used as an article of food or drink, or as a constituent element of such articles.

Numerous specimens of the article in question are in the possession of this office, which will be placed at the disposal of the academy.

Any expense necessarily incurred in conducting this inquiry will be paid upon the presentation of a properly prepared bill for that purpose.

Very respectfully,

GREEN B. RAUM,
Commissioner.

Prof. W. B. ROGERS,
President of National Academy of Sciences,
117 *Marlboro' Street, Boston, Mass.*

The lamented death of President Rogers, to whom this letter was addressed, occasioned some delay, so that the committee asked for, which was appointed by Professor Marsh, the acting president of the academy, was not finally named until the 10th of June, 1882.

The meeting of the committee for organization was held in the city of New York, on the 6th of July, 1882.

After a full discussion of the questions submitted to the committee in the letter of Commissioner Raum, it was decided: First, to have a complete bibliography prepared of the literature of starch-sugar. (In commerce the term "glucose" is used to signify the liquid product, and "grape-sugar" the solid product. The term "starch-sugar" in

this report includes both forms.) Second, to have the addresses of the starch-sugar factories in the United States obtained, and the statistics of the manufacture collected; and third, to have liberal samples of the various products procured, in order that their analysis might be complete and exhaustive.

To facilitate the latter part of the work, a printed circular was prepared by the committee, and mailed to twenty-four starch-sugar manufacturers, being all who were known at that time to the committee. A copy of this circular, including the inquiries contained in it, is appended to this report. (Appendix A.) A complete list of the starch-sugar factories of the United States is also appended. (Appendix B.) Those to whom the circular was sent are marked on this list with a star, (*,) the names of those parties from whom replies were received being given in a separate list immediately following. It will be observed that eighteen of these twenty-four factories responded to the circular. The replies to the questions were full and courteous, and every facility was offered to the committee for the furtherance of its investigations.

At an early meeting, the chemical investigation, including the analysis of samples, was assigned to Professors Gibbs, Chandler, and Remsen, it being understood that the two first named should consider especially the inorganic constituents and impurities found in commercial starch-sugar, and the latter the organic substances present in it, together with the experiments on its physiological action and that of its fermentation products. The preparation of the bibliography of the literature of starch-sugar and the statistics of the starch-sugar industry was referred to Professor Chandler.

It soon became evident to the committee that the subject which it had in hand was too extended to be satisfactorily investigated within the time allotted. A letter was therefore addressed to Commissioner Raum, stating the facts, and asking whether it was essential that the report of the committee should be presented to the Congress then in session. In his reply, the Commissioner stated that he was satisfied that no legislation could be had upon the subject of glucose during that Congress, and therefore suggested that the committee take all the time for the investigation which they required.

Thereupon a somewhat more extended plan of operations was determined on. With the view of actually witnessing the manufacture of glucose and grape-sugar, and of familiarizing themselves with the details of this manufacture upon a commercial scale, the members of the committee, upon invitation of Mr. Hiram Duryea, visited the ex-

tensive works of the Glen Cove Manufacturing Company, at Glen Cove, Long Island, N. Y. These works were in full operation at the time, and every facility was afforded the committee in its investigation of the various processes and in the procuring of samples. The committee also visited the works of the Manhattan Sugar Company, in New York city, but at the time of the visit these works were not in operation.

Since the distance of the starch-sugar factories of the West rendered a personal inspection of these factories impracticable, the committee selected Louis H. Landy, Ph. D., of Columbia College, and commissioned him to make the tour of examination for them, and to collect information and procure samples. This service he performed to the entire satisfaction of the committee. He went first to Buffalo, N. Y., where he visited the works of the Buffalo Grape-Sugar Company, of the American Grape-Sugar Company, and of the Firmenich Sugar-Refining Company. He then proceeded to Chicago, and visited the works of the Chicago Sugar-Refining Company. On his return he stopped at Detroit, and examined the works of the Michigan Grape-Sugar Company. At all these factories he was cordially received, and every opportunity was afforded him for witnessing the processes employed and for collecting samples of the products. In some cases the details of certain of the processes used were given to Doctor Landy in confidence, for the sole use of the committee. With these exceptions, the information thus obtained has been used in drawing up the present report. The samples collected were distributed to the members of the committee for examination and report.

The chemical and physiological investigations went on interruptedly during the spring and summer months of 1883. The character of these investigations, including the methods which were employed and the results which were obtained, is given in the following pages.

II.—STATISTICS OF THE STARCH-SUGAR INDUSTRY.

1.—HISTORICAL.

The starch-sugar of commerce consists chiefly of dextrose, with varying quantities of another kind of sugar, called maltose, and often more or less dextrine, or starch-gum.

Dextrose was first recognized as a peculiar variety of sugar, differing from cane-sugar, or saccharose, by Lowitz, in 1792, who prepared it from grapes.

In 1811, Kirchhoff prepared it from starch by the action of dilute sulphuric acid.

In 1819, Braconnot prepared it from vegetable fibre, or cellulose, such as linen rags, sawdust, &c., by the action of sulphuric acid.

It is generally known in chemical works as dextrose, or dextro-glucose, but is also called glucose, glycose, grape-sugar, starch-sugar, potato-sugar, &c.

It occurs ready formed in honey, associated with cane-sugar and levulose, (or levo-glucose;) in most acid fruits, as the grape, &c., associated with levulose; in the manna of the ash tree, in diabetic urine, &c.

It is produced from cane-sugar, together with levulose, by the action of acids, yeast, &c., the mixed glucoses being called inverted or fruit-sugar.

It is produced from starch by the action of dilute acids. It is also produced from vegetable fibre, or cellulose, by the action of sulphuric acid, and also by a natural process during the ripening of some fruits, especially pears.

Dextrine and other carbohydrates also yield it by the action of acids. There is also a large class of organic bodies, which occur chiefly in plants, called glucosides, which yield glucose, together with other products, by the action of dilute acids or of peculiar ferments. Examples of this class are found in the amygdaline of bitter almonds, the salicine of willow-bark, the myronic acid of mustard-seed, the solanine of potato-shoots, &c.

In 1847, Dubrunfaut pointed out the fact that the sugar produced from starch by the action of barley-malt differed in some respects from dextrose, and proposed for it the name maltose.

O'Sullivan has shown that no dextrose is produced by malt, but that the product consists entirely of maltose and dextrine.

Maltose has since been found to be a constituent of most starch-sugar. It often exceeds in quantity the dextrose, especially when the acid employed in the conversion has been very dilute and the boiling continued for but a short time. Long boiling converts the maltose into dextrose.

2.—THE MANUFACTURE OF STARCH-SUGAR.

In France and Germany potato-starch constitutes the only available material for the manufacture of sugar, but in the United States the starch of Indian corn, or maize, is invariably employed.

The process consists, first, in extracting the starch from the corn in a state of sufficient purity, then transforming this into sugar by treatment with dilute acid, and subsequently neutralizing the acid, purifying, and then concentrating the product.

The details of the various steps differ in different establishments, but the general character of the process is the same as when first proposed in 1811, by Kirchhoff.

A.—Extracting the starch.

1. *Steeping.*—The corn is placed in large wooden vats, or tanks, holding from 500 to 1,000 bushels. It is covered with hot water, having a temperature of about 160° F. in summer and 185° F. in winter. The corn immediately reduces the temperature of the water to about 140° or 145° F. Every six hours the water is drawn off and replaced with fresh water, at about 130° or 135° F. If signs of fermentation appear, the water is changed oftener, the object being to soften the corn without permitting it to become sour. From two to four days are required, the time depending on the hardness of the corn. Some manufacturers add to the water a little sulphuric acid, sulphurous acid, or caustic soda.

2. *Grinding.*—The softened corn is next ground between buhrstones, a stream of water running continuously into the hopper of the mill. As it is ground, the thin paste is carried by the stream of water upon the shakers, or sieves. Some manufacturers pass the paste through a second mill before it is sent to the shakers, others send it from the first mill to the shaker, and submit the husks to a second mill, employing a second shaker.

3. *Separation of the starch.*—The paste, or pulp, from the mill is passed over shakers, or starch-separators. These are inclined sieves of silk bolting-cloth, which are kept in constant motion, and sprayed with jets of water. The starch passes through the bolting-cloth with the water, as a milky fluid, while the coarser cellular tissue, or husk, of the corn is left behind. This residue is pressed to remove water, and sold as cattle-food.

4. *Cleaning the starch.*—The water from the shakers, holding the starch in suspension, is run into wooden vats, where the starch settles, and the water is drawn off and discarded. The starch is next thoroughly agitated with fresh water, to which a small quantity of caustic soda or carbonate of soda has been added. The object in adding the alkali is to dissolve and remove the gluten and other albuminoids, oil, &c.

5. *Collecting the starch.*—The mixture of starch and alkaline water is allowed to flow upon long wooden runs, or tables, which are from 1 to 2 feet wide and 125 feet long. Twenty-five or fifty of these runs are required for the treatment of 1,000 bushels of corn daily. These runs have a slight incline, and as the stream flows slowly upon the upper end the starch is deposited, while the alkali-wash, bearing lighter

particles of cellular tissue, gluten, &c., flows off from the lower end. Some manufacturers prefer to treat the starch with alkali after it has been collected on the runs.

6. *Washing the starch.*—The starch is next shovelled up from the runs and mixed with water, and then again allowed to settle. The water is drawn off and the washing repeated, sometimes with a slight addition of hydrochloric acid; finally, the thoroughly purified starch is mixed with the proper amount of water for the converter. The yield varies with the quality of the corn; a fair average would be, per bushel:

Starch	30 pounds.
Cattle-food	14 pounds.
Waste	12 pounds.
Total	56 pounds.

B.—Transforming the starch into sugar.

7. *Conversion*, as it is termed, is accomplished in either open or closed converters, and in some establishments the process is partially executed in open and finished in closed converters.

The open converters are wooden vats, generally of 3,000 or 4,000 gallons' capacity, sufficient for the treatment of the starch from 1,000 bushels of corn.

They are provided with banks of copper steam-coils, either closed or perforated. The closed converters are generally of copper; they are provided with safety-valves, and are made of sufficient strength to withstand with safety a pressure of six atmospheres.

Sulphuric acid is generally employed in the conversion, though other acids have been used. The quantity of acid employed varies with the object of the manufacturer. For the production of "glucose," a liquid product which contains much dextrine, a smaller quantity is used than when solid "grape-sugar" is to be produced, in which the conversion into dextrose is much more complete. The proportion varies from one-half pound oil of vitriol to one and a quarter pounds per 100 pounds starch.

When the *open converter* is used, a few inches of water is introduced and the acid added, or half the acid may be added to the starch-mixture. The acid-water is brought to a boil, and the starch, previously mixed with water to a gravity of from 18° to 21° Baumé, is slowly pumped in, keeping the liquid constantly boiling. When all the starch has been introduced, the whole is boiled until the iodine test ceases to give a blue color and shows a dark-cherry color. The boiling is usually continued for about four hours.

When the *closed converter* is used, the starch is mixed with water to a gravity of from 11° to 16° Baumé. This, with the acid, is introduced into the converter, and the whole is heated under a pressure of from 45 to 75 pounds per square inch. The time required for the conversion is much shorter than in the open converters.

The use of open and closed converters successively is often resorted to. The starch and water, of a gravity of 15° or 16° Baumé, is first boiled in the open converter for from one to two hours, then transferred to the closed converter, and boiled under a pressure of from 45 to 75 pounds per square inch. The time of this boiling varies from ten minutes to half an hour.

The use of other acids.

C. Krötke, in 1871, introduced in Germany the use of nitric acid in conjunction with sulphuric acid, in the proportion of two ounces of nitric acid to every pound of sulphuric acid.

Phosphoric acid has been patented as a substitute for sulphuric acid.

In 1858, R. Wagner suggested the use of oxalic acid in place of sulphuric acid.

E. Delarue & Co., of Paris, patented the use of oxalic or tartaric acid, in 1879. Finally, Bachet and Savalle state that under a pressure of eight atmospheres carbonic acid readily converts starch into dextrose.

NOTE.—The committee does not feel at liberty to publish the peculiar processes employed in the different factories, as these were communicated in confidence.

8. *Neutralization.*—When the starch has been sufficiently converted for the desired product, the liquor is run into the neutralizing-vats. Here a sufficient quantity of marble-dust is added to completely neutralize the sulphuric acid, converting it into sulphate of lime. A little fine bone-black is generally added at the same time. It is then allowed to cool and to deposit the sulphate of lime. A small portion of this sulphate of lime is retained in solution, and, although most of this will be removed by the subsequent filtration through bone-black, a minute quantity is always found in the finished product. Kunheim & Co., in Berlin, propose to remove this by a small addition of oxalate or phosphate of baryta.

9. *Bag filtration.*—The liquor, having a gravity of 12° to 18° Baumé, (light liquor,) is next filtered through bag filters, of cotton cloth, or filter-presses, or both.

10. *Treatment with sulphurous-acid gas.*—In many establishments this is resorted to at this point in the process, to prevent fermentation, and probably to some extent as a bleaching agent.

11. *Bone-black filtration.*—The liquor is now passed through bone-black filters, by which it is decolorized, and at the same time freed from various other soluble impurities.

12. Concentration is effected in the vacuum-pan, at a temperature of about 140° F., until it has a gravity of from 28° to 30° Baumé. This is called heavy liquor.

13. *Second bag filtration.*—During the concentration a certain quantity of sulphate of lime separates, and it is found advisable to remove it when the liquor reaches the gravity of 28° or 30° Baumé. It is therefore filtered through the bag filter or filter-press.

14. A second treatment with sulphurous acid is resorted to in some factories, the acid being added in the vacuum-pan, or to the liquor as it comes from the bag filters.

15. *Second bone-black filtration.*—The heavy liquor is now filtered a second time through animal charcoal, to secure a further decolorization and purification.

16. The final concentration is accomplished by boiling the liquor in the vacuum-pan till it exhibits a gravity of from 40° to 42° Baumé while hot. It is then let down from the pan and subjected to—

17. A third filtration, through a filter-press, to remove the sulphate of lime, which separates during the final concentration.

In some establishments the liquor is passed but once over bone-black; in fact, all of the steps which have been mentioned are followed only by those manufacturers who desire to produce the best products.

18. *Final treatment.*—The resulting product will vary in character according to the amount of acid used and the duration and temperature of the conversion. The variety in which the conversion has been least complete is called "glucose" in the trade; that in which the conversion is more complete, and which solidifies in the packages in consequence, is called "grape-sugar."

An ingenious process has been invented by Dr. Arno Behr for causing the grape-sugar to crystallize. While it is still liquid there is added to it a very small quantity of crystallized anhydrous dextrose. The mixture is filled into moulds, and in about three days it is found to be a solid mass of crystals of anhydrous dextrose. The blocks are then placed in a centrifugal machine to throw out the still liquid sirup, and the anhydrous dextrose remains as a crystalline mass.

Starch-sugar appears in commerce in a great variety of grades, under the following names:

(*a.*) The liquid varieties:

Glucose.
Mixing-glucose.
Mixing-sirup.
Corn-sirup.
Jelly glucose.
Confectioners' crystal glucose.

(*b.*) The solid varieties:
Solid grape-sugar.
Clipped grape-sugar.
Granulated grape-sugar.
Powdered grape-sugar.
Confectioners' grape-sugar.
Brewers' grape-sugar.

One establishment puts upon the market two varieties of starch-sugar, under the names—

1. Maltose, or maltose sirup, for brewers;
2. Maize sugar or sirup, for confectioners;

and claims that they do not contain grape-sugar, (dextrose,) but consist essentially of maltose.

The committee visited the factory, but it was not in operation, nor were the proprietors disposed to inform the committee of the nature of their processes, which they deemed it important to hold secret. They kindly supplied samples, however, and these are enclosed in the list of analyses.

3.—MAGNITUDE OF THIS INDUSTRY.

The manufacture of starch-sugar came into existence during the continental blockade which prevailed under Napoleon I. With the raising of this blockade, the industry practically disappeared, as starch-sugar could not compete with the colonial sugar of the cane. The industry gradually revived, however, and finally acquired very considerable importance.

Although the committee has been able to secure a very complete list of all the starch-sugar factories in the country, it has been found practically impossible to present any very clear idea of the magnitude of the business. This is due to the great irregularity of the working of these factories. When corn is low in price, and cane-sugar, molasses, and barley high, all the establishments referred to are in full operation, and the production of starch-sugar is proportionally large. When the opposite conditions prevail, as they do at the present time, the starch-sugar works are closed. Twenty-nine factories exist in the United States, with a capacity ranging from 500 to 8,000 bushels of corn a day, most of them using about 2,000 bushels. The committee believes that it is safer to estimate an average capacity of 1,500 bushels, which would make the total capacity 43,000 bushels per day.

The census bulletin No. 304 gives seven glucose factories, with a capital of $2,255,000, and a gross value of products of $4,551,212.

Payen, in the third edition of his "Chimie Industrielle," published in 1855, places the French production of potato-starch sugar at 5,000,000 kilograms, or 5,500 tons, per annum.

The manufacture of starch-sugar from potatoes is an old manufacture in Germany, and very complete statistics showing its extent have been published from time to time. Wagner, in the second edition of his "Chemische Technologie," states that there were in 1874 sixty glucose factories in the German empire, with an annual production of 360,000 ctrs. (19,800 tons) sirup, and 500,000 ctrs. (27,500 tons) solid sugar. Post, in his "Chemische Technologie," places the production during the fiscal year 1877–'78, of the forty-five factories in Germany, at 5,931 tons starch-sirup and 8,135 tons starch-sugar, at a price for the sugar varying from $82.50 to $84 per ton.

It is stated in Wagner's "Jahresbericht" for 1877 that 2,221 tons of starch-sugar were used in the manufacture of beer in Germany during the year 1876. The following table, giving the production for the fiscal year 1881–'82, is translated from Wagner's "Jahresbericht der Chemischen Technologie für 1882:"

Production of starch-sugar in the German Customs Union in fiscal year 1881–'82, *in tons of* 2,000 *pounds.*

States and provinces.	Number of factories.	Quantity of starch converted.				Quantity of sugar made.			Average selling-price per 2,000 pounds.		
		Starch made.		Starch purchased.		Grape-sugar, (solid.)	Glucose, (liquid.)	Sugar color.	Grape-sugar, (solid.)	Glucose, (liquid.)	Sugar color.
		Moist.	Dry.	Moist.	Dry.						
Prussia—											
Province of Brandenburg	15	18,961	2,055	32,852	11	14,920	14,705	834	$62 30	$63 90	$83 25
Province of Pomerania	*4	192	.....	131	.....	167	27	.....	54 00	67 25	.....
Province of Posen	1	333	.....	1,729	.....	199	806	242	54 00	58 50	58 50
Province of Silesia	4	942	.....	8,333	.....	1,566	372	289	53 55	54 45	89 55
Province of Saxony	4	2,279	226	1,093	.....	1	1,476	346	67 50	61 65	78 98
Rhine province	2	1,333	.....	.....	.....	888	.....	.....	72 00	.....	.....
Total	30	24,045	2,281	44,138	11	17,742	17,386	1,711	61 87	63 45	79 87
Bavaria	1	.....	.....	.....	.....	40	.....	.....	67 25	.....	.....
Baden	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hesse	*3	528	3	.....	44	461	.....	.....	65 25	.....	.....
Mecklenburg	1	861	.....	.....	.....	.....	533	.....	.....	54 00	.....
Brunswick	1	500	.....	.....	.....	.....	333	.....	.....	47 25	.....
Alsace	2	936	.....	331	142	342	528	.....	67 25	81 00	.....
Customs Union, 1881–'82	†39	26,869	2,284	44,469	197	18,384	18,782	1,711	62 10	63 22	79 87
In fiscal year 1880–'81	†45	21,862	911	28,680	362	11,768	17,970	855	74 25	72 00	82 35

*Of these, two were not running.
†Of these, four were not running in 1881–'82 and seven in 1880–'81.

4.—USES OF STARCH-SUGAR.

Both glucose and grape-sugar find extensive application for a great variety of purposes as substitutes for cane-sugar or for barley.

The most general purposes for which starch-sugar is used are:

1. For the manufacture of table-sirup. This consists of a nearly or quite colorless glucose, with a sufficient addition of the cane-sirup from the sugar-refinery to give it the flavor and appearance of a highly refined molasses. The quantity of cane-sirup added varies from 2 per cent. up to perhaps 33 per cent.

2. As a substitute for barley-malt in the brewing of ale or beer. This is really a substitution of Indian corn for barley; but it constitutes a very imperfect substitute, as the corn, by the treatment employed in extracting its starch for conversion into glucose, is completely deprived of all the nitrogenous bodies and mineral salts which it originally contained. Hence, the glucose alone, which is simply transformed starch, is substituted for the entire barley grain, with its great variety of valuable constituents. This is not true, however, of the maltose produced from the entire corn by the action of malt. This material contains all the soluble constituents of the corn, together with the additional substances which are rendered soluble by the action of the diastase of the malt.

3. As a substitute for cane-sugar in confectionery.

4. For the adulteration of cane-sugar, to which it is added to the extent of 20 or more per cent.

In the appendix will be found some analyses of commercial cane-sugar.* Although the committee has the most positive evidence that grape-sugar has at times been used to a considerable extent in adulterating cane-sugar, yet the samples of commercial sugar which have been collected from time to time in New York city by the inspectors of the city and State boards of health have never shown any such addition.

5. As a substitute for cane-sugar in canning fruits and in the manufacture of fruit-jellies.

6. For the manufacture of artificial honey. This is neatly put up in glass jars containing a small piece of genuine honey-comb.

7. In the manufacture of vinegar.

8. In the manufacture of liquor-coloring, used both in mixing liquors and in making artificial liquors.

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* See Appendix C of this report.

9. Other more limited applications: In the manufacture of wine; by the baker in making cakes; in cooking, in the preparation of sauces; as an addition to some canned meats, especially corned beef; in the preparation of chewing-tobacco; in the manufacture of printers' rollers; and in the manufacture of some kinds of ink.

The demand for glucose and grape-sugar for these purposes is extremely variable, and depends on the relative prices of corn and of the articles for which this kind of sugar is substituted, especially sugar-house sirup and barley.

III.—ON THE NATURE OF THE COMMERCIAL PRODUCTS.

1.—VARIETIES OF SUGAR.

Before giving the methods of analyses employed and the results obtained, it is desirable that the meaning of the names of the substances should be stated as clearly as possible, in order that those who are not chemists may be able to read the report understandingly.

Sugar is to the chemist a collective name. There are two classes of sugars, closely related to each other. Of one of them, our ordinary cane-sugar, as well as beet-sugar, which is chemically identical with cane-sugar, is an example. Of the other class, grape-sugar, a glucose or dextrose, the sugar of grapes and honey, is the principal example. Another example of the grape-sugar group is the so-called fruit-sugar, or levulose. Dextrose and levulose have the same chemical composition, but different properties. The difference between them is especially marked in connection with the action towards polarized light. While the former (dextrose) turns the plane of polarization to the right, the latter (levulose) turns it to the left. Pure dextrose is stated to have two-thirds the sweetening power of cane-sugar.

When cane-sugar is boiled with a dilute acid, as sulphuric or hydrochlorine acid, it is converted into equal parts of grape-sugar (dextrose) and fruit-sugar, (levulose.)

The names grape-sugar, glucose, and dextrose, when used by a chemist, are meant to designate the same substance. In commerce, however, as already stated, the names "grape-sugar" and "glucose" have a somewhat different meaning, the former being applied to the solid and the latter to the liquid products.

One of the first problems which presented itself to the committee in the examination of the collected samples of grape-sugar and glucose was the determination of their composition. Assuming that in the process of manufacture perfectly pure starch, acid, and water were

used, that nothing foreign was introduced, and that the transformations were carried to the end, the product would be pure dextrose. But the conditions under which the manufacturers work permit of considerable variations in the composition of the products. In the first place, the transformation of the starch into dextrose may not be perfect. Indeed, if sulphuric acid be used to effect the transformation, it is impossible, even under the most favorable conditions, to transform more than 95 per cent. of the starch into dextrose. The extent of the transformation is dependent upon the strength of the acid, the temperature, and the time during which the heating is continued. The intermediate products are chiefly maltose and dextrine, which may be present in greater or smaller quantities, according to the way the process is carried out. If the product is to be used in the form of sirup, then the presence of maltose and of dextrine is objectionable, as the latter has no sweetening power, and the former very little, if any, though they do not produce injurious effects upon the system. If it is to be used in the manufacture of beer, it should be borne in mind that dextrine does not undergo fermentation. Again, the products may be more or less contaminated by mineral substances, such as salts of lime, which are commonly used in the manufacture. Hence, in the analyses of our samples we directed attention, first, to the substances formed by the transformation of the starch, and second, to the accidental mineral impurities.

2.—ORGANIC CONSTITUENTS.

Many analyses of the commercial products have been made by others, but we have thought best to collect samples ourselves from some of the important factories of the country, taken at random, and to have analyses made under our own supervision, for the purpose of ascertaining how nearly the various products met with in the market approach the same composition.

The samples collected, as stated in full in the first part of the report, were divided into the necessary number of parts, and one part of each was forwarded to each member of the committee. The bottles and packages were simply numbered, and the members of the committee had no knowledge of the original source of the samples. In the results which will be given below the samples will be referred to by their respective numbers. The estimations of the relative quantities of dextrose, maltose, and dextrine were made by a method suggested by H. W. Wiley. (Chemical News, vol. 46, p. 175.) The theory of the process may be stated in a few words. All three of the bodies present,

viz., dextrose, maltose, and dextrine, are optically active, turning the plane of polarization to the right, though not to the same extent, the specific rotatory power of dextrose being 52, that of maltose 139, and that of dextrine 193. Now, if a solution containing all three is examined with a polariscope, the total rotation observed is due to the action of the three:

$$P = 52\,d + 139\,m + 193\,d' \ldots\ldots\ldots (1).$$

If the solution be treated with mercuric cyanide in excess, all the dextrose and maltose will be destroyed, and only the dextrine left unchanged. If a second observation be now made with the polarizing apparatus, the rotation observed will give the quantity of dextrine present, for we have

$$P' = 193\,d' \ldots\ldots\ldots (2),$$

from which the value of d', or the amount of dextrine, may be easily calculated. Subtracting (2) from (1), we have

$$P - P' = 52\,d + 139\,m \ldots\ldots\ldots (3).$$

When a mixture of the three substances is treated with Fehling's solution, the dextrose and maltose are reduced. The total reduction gives then the reducing per cent. of the dextrose, d, + that of the maltose, m. Since maltose, however, has a reducing power as compared with dextrose of only 0.62, we have the equation

$$R = d + 0.62\,m \ldots\ldots\ldots (4).$$

Multiply this by 52, which gives

$$52\,R = 52\,d + 32.24\,m,$$

and subtract from (3). This gives

$$P - P' - 52\,R = 106.76\,m \ldots\ldots\ldots 5),$$

whence

$$m = \frac{P - P' - 52\,R}{106.76} \ldots\ldots\ldots 6),$$

$$d = R - 0.62\,m \ldots\ldots\ldots 7),$$

and

$$d' = \frac{P'}{193}$$

For further details of the process, reference is made to the paper by Wiley.

The copper solution used is made up in proportions stated below:

Copper sulphate	34.632 grams.
Sodium-potassium tartrate	173.0 grams.
Potassium hydrate	125.0 grams.

The substances were dissolved in water and the solution diluted to one litre.

The mercuric cyanide solution used contained, in 1 litre, 120 grams mercuric cyanide and 25 grams of potassium hydrate; 25 C. C. of this solution were sufficient for solutions not containing more than 65 per cent. of reducing substances, and 30 C. C. for solutions containing more than that amount.

The copper solution (10 C. C.) diluted with its own volume of water was in all cases contained in a small Erlenmeyer flask. After heating to boiling, the sugar solution was run in, and the whole again heated to boiling. For the first trial experiment the sugar solution was added in small portions at a time until the blue color disappeared. The approximate amount of the sugar having thus been determined, several new titrations were made, the sugar solution being added all at once, until two successive titrations, differing by 2 C. C. in the amount of sugar solution added, (the first giving the copper reaction with potassium ferrocyanide, and the second not giving it,) were obtained.

Water was estimated directly by mixing the sample in a small porcelain dish with clean, dry sand, and heating in an air-bath for three hours, at 110° F. In some cases, as of maize-sirup, family sirup, and maltose-sirup, three hours were found to be too long, as in that time the sample was largely converted into caramel.

Table I.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
Per cent. reducing matter.	48.5	43.6	42.7	39.3	.....	41.2	73.8	87.3	93.2	99.37	.....	74.2	74.2	41.0	72.1	41.9	39.0	37.2	40.0
Total rotation, (degrees).....	20.7	19.7	21.7	19.33	.....	21.7	9.7	9.17	10.0	10.4	.....	11.0	11.5	20.66	11.0	19.5	20.1	22.33	18.66
Rotat. after merc. cyan.,(degrees).	11.5	14.9	16.3	4.33	.....	15.8	1.65	.....	.....	.....	.....	2.5	3.5	15.0	3.5	15.0	16.0	17.5	12.5
Per cent. water.....	14.2	17.4	16.1	22.6	.....	15.3	15.1	12.4	7.3	0.62	.....	17.5	14.0	19.2	16.6	20.8	19.3	17.2	17.0

Table II.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
Per cent. dextrose	36.5	42.8	39.8	38.6	.....	36.5	72.7	87.1	93.2	99.4	.....	72.0	73.4	37.0	72.1	41.5	39.0	34.3	40.0
Per cent. maltose	19.3	1.3	4.7	1.1	.....	7.6	1.8	0.3	.....	.....	.....	3.6	1.3	6.5	.....	0.6	.....	4.6	.....
Per cent. dextrine	29.8	38.4	42.1	38.8	.....	40.9	4.2	.....	.....	.....	.....	6.4	9.1	38.8	9.1	38.8	41.4	45.3	32.4
Per cent. water	14.2	17.4	16.1	22.6	.....	15.3	15.1	12.4	7.3	0.6	.....	17.5	14.0	19.2	16.6	20.6	19.3	17.2	17.0
Total.....	99.8	99.9	102.7	101.1	.....	100.3	93.8	99.8	100.5	100.0	.....	99.5	97.8	101.5	97.8	101.5	99.7	101.4	89.4

For these samples one and a half hours were found to be long enough. The figures obtained in each case were:

1. Percentage of reducing matter;
2. Total rotation;
3. Rotation after treatment with mercuric cyanide; and
4. Percentage of water.

Nineteen numbered samples in all were sent for examination. Of these, seventeen were analyzed, No. 5 being wanting in the lot as received, and No. 11 evidently being a sample of impure cane-sugar. In Table I the figures are given as obtained, and in Table II the percentages of the constituents are given as calculated by the method given above.

Nos. 7, 8, 9, 10, 12, 13, and 15 were solids; the others, liquids. Nos. 7 and 19 evidently contained considerable burnt sugar, to which fact the curious results obtained in the analyses are at least partly to be attributed.

Nos. 8, 9, and 10 are specially pure specimens of grape-sugar, and certainly do not represent the average composition of commercial grape-sugar. As fair samples of commercial grape-sugar, Nos. 7, 12, 13, and 15 may be taken. In these, as will be seen, the amount of dextrose present is between 72 and 73.4 per cent., while the dextrine varies from 4.2 to 9.1 per cent.

As regards the liquid products, the so-called glucoses, it will be seen that the amount of dextrose present in them varies from 34.3 to 42.8 per cent., and the amount of dextrine from 29.8 to 45.3 per cent.

It should be said that the constituents thus far mentioned are of themselves not injurious when taken into the system, though, as above stated, neither the dextrine nor the maltose has any sweetening power, and hence they have no value as constituents of table sirups or sugars.

3.—INORGANIC CONSTITUENTS.

The results obtained in the examination of the samples for mineral impurities are here given. The analyses were made by J. S. C. Wells, Ph. D., of the School of Mines of Columbia College.

Samples of starch-sugar examined.

Number.	Mark.	Factory.	Water.	Ash.	Sulphuric acid, (SO_3.)	Chlorine.	Ferric oxide.	Lime.	Magnesia.	Alkalies.
1	Glucose	A.....	11.50	0.325	0.202	0.055	0.020	0.012	0.027	0.097
2	Mixing-sirup	A.....	17.15	0.370	0.177	0.060	0.015	0.008	0.023	0.140
3	Glucose	B.....	12.18	0.520	0.039	0.255	0.030	0.066	0.005	0.157
4	Mixing-sirup	B.....	24.25	0.890	0.220	0.155	0.015	0.014	0.031	0.380
6	Glucose	C.....	14.50	0.420	0.161	0.065	0.010	0.014	0.025	0.150
7	Brewers' grape-sugar	D	12.98	0.380	0.055	0.010	0.055	0.029	0.038	0.070
8	Confection'rs' grape-sugar	D	10.00	0.140	0.091	0.010	0.025	0.025	0.007	0.017
9	Cakes from centrifugal	D	4.20	0.220	0.139	0.020	0.035	0.035	0.023	0.016
10	Anhydrous grape-sugar	D	0.53	0.025	0.009	0.000	0.006	0.004	0.004	0.000
11	Mixed grape and cane sugar	D	1.75	0.330	0.029	0.120	0.025	0.025	0.004	0.120
12	Grape-sugar	A.....	13.25	0.495	0.230	0.050	0.100	0.047	0.004	0.140
13	Grape-sugar	E.....	11.55	0.750	0.395	0.025	0.030	0.029	0.004	0.320
14	Glucose	F.....	23.10	0.335	0.094	0.105	0.010	0.012	0.009	0.134
15	Grape-sugar	F.....	16.50	0.335	0.159	0.050	0.055	0.027	0.004	0.102
16	Maltose	G	22.26	1.060	0.056	0.125	0.000	0.021	0.101	0.337
17	Maize-sirup	G	24.46	0.815	0.065	0.120	0.010	0.008	0.013	0.374
18	Glucose	H.....	18.41	0.335	0.053	0.025	0.015	0.080	0.034	0.012
19	Family sirup, (mixed cane and grape)	H.....	21.17	1.535	0.094	0.205	0.040	0.226	0.088	0.340

Careful research was made for tin, copper, and other metallic impurities, but none were found.

Sulphuric acid and chlorine were determined in the solution of the original samples, 10 grams being used in each case. Oxide of iron, lime, and magnesia were determined in the ash. The ash itself was determined by moistening 10 grams of the material with 3 or 4 C. C. of sulphuric acid, and then incinerating.

The French plan, of deducting one-tenth from the weight of the ash for the sulphuric acid added, was not, however, adopted.

To secure an approximate determination of the alkalies, the lime and magnesia were calculated as sulphates, and, with the oxide of iron, were subtracted from the total ash. The residue being counted as alkaline sulphates, and divided by 2, the result represents approximately the alkalies.

IV.—IS THE USE OF "GLUCOSE," OR "GRAPE-SUGAR," INJURIOUS TO HEALTH?

This question is certainly one of the most important ones that can be asked regarding the substance under consideration. It has been discussed very freely, but on a very insufficient basis of facts. Indeed, so far as the products made from corn-starch are concerned, it appears that no experiments have ever been made with reference to their effects upon the system. It is essential in a discussion of this subject to keep clearly in mind the fact that while it is undoubtedly true that the pure chemical substances, dextrose, maltose, and dextrine, are not injurious, there may be other substances present in small quantities in the commercial products, and that these may be capable of producing injurious effects; or it may be true that when the commercial products are changed by fermentation, substances of injurious character may be formed or left unfermented.

In Germany, where large quantities of glucose are made from potato-starch, experiments bearing upon the question of the presence of injurious constituents have been made with the commercial products. Some of the results obtained seem to indicate that after fermentation of potato-sugar there are left substances which are injurious, while others seem to indicate that this is not true. Among those who have experimented on the subject, A. Schmitz, Nessler, and Freiherr von Mering should be specially mentioned. Schmitz (Beiträge zur diätetischen Beurtheilung des gallisirten Weines, Bonn, 1878) fermented potato-sugar, and, evaporating the products down to small volumes, administered known quantities of the residues to cats and dogs, and in a few cases to human beings. The results obtained were uniform, and showed that the substances caused sickness, as headache, sweating, and loss of appetite.

Later, Nessler (Wochenblatt des landwirthschaftlichen Vereins im Grossherzogthum Baden, 1880) undertook similar experiments, and obtained similar results. He experimented upon his assistant and himself. One of his experiments is here described. He allowed a 20 per cent. solution of potato-sugar to ferment after the addition of a small quantity of hops. After the fermentation was over, the liquid was filtered, a litre evaporated down to a sirup, and then diluted up to 100 C. C. This solution had a disagreeable, bitter taste. Of it, Nessler took 50 C. C. at 7 A. M., and the same quantity at 10 A. M., each portion corresponding to 100 grams of potato-sugar. Toward noon he began to feel uncomfortable, but not so much so that he could positively attribute his condition to the beer extract. At 2 P. M., the residue from 100 grams potato-sugar was again taken; and now in about an hour there

followed profuse perspiration and violent headache, both of which continued until night. A few days later, his assistant took the residue from 90 grams sugar, the fermented liquor having been evaporated down to two-fifths its original volume. He soon experienced difficulty in breathing and broke out in a cold sweat; at dinner he had no appetite, and was obliged to throw up the little soup he did take. In the afternoon he had a violent headache, which continued until evening.

Nessler concludes his paper with these words: "It is hence beyond a doubt true that in the liquid obtained in the fermentation of potato-sugar there are substances injurious to health. If the question is asked whether this is true of all commercial potato-sugars, as well as of the sugar examined, we cannot give a definite answer.

"In the case of all varieties of potato-sugar thus far examined, there remains after evaporation of the fermented liquid a bitter-tasting extract, which turns the plane of polarization to the right, and it is very probable that all of them may act injuriously upon the health, in varying degrees, according to the greater or less purity.

"As in buying the sugars it is not possible to determine whether the harmful substances are present or not, potato-sugar should not be used for the preparation of beverages,* until it can be prepared in perfectly pure form."

Directly opposed to the results of Schmitz and Nessler are those obtained by Freiherr von Mering. (Deutsche Vierteljahrschrift für öffentliche Gesundheitspflege, vol. 14, p. 325.)

This writer experimented upon dogs, cats, rabbits, and human beings, in much the same way as Schmitz and Nessler had done, and he concludes that the unfermentable residues from potato-sugar are not at all objectionable.

Later, Schmitz (Deutsche Vierteljahrschrift für öffentliche Gesundheitspflege, vol. 14, p. 481) replied to Von Mering, upholding his first results.

It hence appears doubtful whether there are injurious substances in potato-sugar, and it is highly desirable that the experiments on this subject should be repeated by those who have not thus far taken active part in the discussion. Even though it should eventually be shown that potato-sugar is or is not objectionable, it would not necessarily follow that the same is also true of maize-sugar.

As, so far as we know, no experiments had been made upon starch-sugar, we carefully repeated the experiments described above, using

* One of the uses to which potato-sugar is put in Germany is as an addition to poor wine.

several of the samples of glucose and grape-sugar, the analyses of which are given in the preceding part of this report.

We were fortunate in securing for this work the assistance of Dr. J. R. Duggan, of the Johns Hopkins University, who has for some time past been occupied in experiments upon fermentation, and who is hence fully familiar with all the precautions necessary to secure reliable results. The fermentations were carried on in a new cellar, which fortunately chanced to be available, so that the danger of abnormal fermentation was reduced to a minimum.

Pure glucose cannot be fermented by the simple addition of yeast in small quantity; for yeast, like all living matter, requires certain nitrogenous and inorganic materials for its own nourishment. As has been shown by Pasteur, this want may be supplied by the addition of certain salts, such as ammonium tartrate, calcium phosphate, &c.; but as these cannot be added in exactly the necessary proportions, some would be likely to remain in the solution after fermentation was complete, and, if taken into the stomach along with the glucose residue, would probably produce an effect of its own which might be attributed to the glucose.

It is not easy to obtain in sufficient quantity a liquid furnishing a proper medium for the growth of yeast which does not also contain glucose; and, for this reason, it was first necessary to determine the effect, if any, of the unfermentable residue from this glucose.

Experiments Nos. 1, 2, and 3 were made for this purpose. The nutrient liquid used was barley-wort, on account of the fact that it is most commonly used in brewing for commercial purposes.

This liquid contains much more nitrogenous matter than is necessary to support the yeast during its fermentation, and therefore it still forms a good medium for the growth and development of yeast after it is considerably diluted with a solution of glucose.

The method of experimenting was as follows: The barley-wort, of the concentration usually employed for making beer, was mixed with the glucose solution, and the whole heated to boiling by passing steam through a coil of block-tin tubing placed in the tub. The tube was then connected with the hydrant, and water passed through it until the solution was well cooled. It was then allowed to flow slowly over a wide board, for the purpose of thoroughly aerating it. The temperature was reduced to about 10° C., and about a pint of yeast added. Fermentation was carried on in a cool vault, and was allowed to continue until very little sugar was left in the solution and the yeast had all settled to the bottom of the tubs. A sufficient quantity of beer was

then siphoned off and evaporated slowly over the water-bath to about one-tenth its volume. The residue consisted principally of dextrine, nitrogenous matter from the wort, glycerine, succinic acid, and probably other products of fermentation in very small quantities. It formed a thick, dark-colored sirup, of very disagreeable taste, especially when wort containing hops had been used. For this reason, sweet-wort was used in most of the experiments. All of the fermentations were carried on by the low process—that is, with bottom yeast at a temperature of from 8° to 10° C.

Two experiments were tried with the high process, but it was found to be impracticable on the small scale, on account of the development of bacteria, due to the higher temperature. As the difference in the two processes is essentially one of temperature only, there is no reason to suppose that they could in any way give different results.

The amount of yeast added to each tub was about one-half litre. This was carefully examined with the microscope, both before and after fermentation, to guard against the presence of foreign ferments that might produce injurious products. The glucoses used were of the various manufactures already mentioned, and embraced the different grades of solid and liquid productions.

The extracts were taken at different hours of the day, both before and after meals. The quantity usually taken contained the residue from 125 grams of glucose; but in experiment No. 8 this quantity was increased so as to correspond to 200 grams. It seems useless to try still larger quantities, for it is probable that if much more was taken the normal products of fermentation, such as succinic acid, would produce some effect.

Experiments 1 *and* 2.—Thirty litres of sweet-wort and the same quantity of hopped wort were separately fermented, the process lasting, in each case, one week. Five litres of the resulting liquid were evaporated to 750 C. C., and 300 C. C. of the extract taken internally. The same experiment was tried by two individuals, but no effect was produced. The amount of extract taken corresponded to two litres of the beer.

Experiment 3.—In this experiment there were used 15 litres of sweet-wort, to which were added 15 litres of a 12.5 per cent. solution of cane-sugar. Five litres of the liquid were evaporated to 500 C. C., and 200 C. C. of the extract taken, with no effect. The amount of extract taken represented 125 grams of cane-sugar.

Experiment 4.—Fermented 15 litres sweet-wort and 15 litres of a 12.5 per cent. solution of grape-sugar. (Sample No. 12.) Five litres of the

liquid were evaporated to 500 C. C., and 200 C. C. taken. No effect was produced. On the following day, the same amount of residue was taken, and with no effect. The amount of extract taken corresponded to 125 grams of glucose in each experiment.

Experiment 5.—Fifteen litres of sweet-wort and 15 litres of a 12.5 per cent. solution of grape-sugar (Sample No. 7) were fermented. The same amount of extract was taken as in the last experiment, with the same results.

Experiment 6.—The details of this experiment were exactly the same as those of the last. The substance was a commercial glucose. (Sample No. 14.)

Experiment 7.—Fifteen litres of hopped wort, with 7.5 litres of a 25 per cent. solution of commercial glucose, (Sample No. 1,) were fermented. Four litres of the fermented liquid were evaporated down to 400 C. C., and of the residue 150 C. C. were taken. No effect was felt.

Experiment 8.—Fifteen litres of hopped wort and 7.5 litres of a 25 per cent. solution of grape-sugar (Sample No. 13) were fermented. Five litres of the fermented liquid were evaporated to 500 C. C., and 200 C. C. taken. No effect was felt. The extract then represented 160 grams of grape-sugar.

The experiments described above occupied about two months, during which time Doctor Duggan repeatedly took large quantities of the extracts. At the end of the experiments, and during the entire period, his health continued excellent.

There was nothing whatever to indicate that the extracts contained anything injurious to health, and the conclusion seems to be fully justified that the samples examined by us, and which we have every reason to believe were fair average samples of the substances found in the market, contained nothing objectionable from a sanitary stand-point. In the experiments the experimenter took into his system everything that could possibly be objectionable contained in from 120 grams to 160 grams of the glucose, or grape-sugar, *i. e.*, from a quarter to a third of a pound. It must be borne in mind, further, that the extract which was taken into the stomach must have contained any objectionable mineral as well as organic substances present in the glucose employed. Hence, the results seem to be final as regards the injurious natures of glucose, or grape-sugar, made from maize.

These experiments extended over a period of only about two months. On the question, therefore, whether any injurious effect would follow the continuous use of this material, the committee has no information.

Our experiments have, of course, no direct connection with those of

Schmitz, Nessler, and Von Mering, already referred to. These gentlemen experimented upon potato-sugar as furnished by manufacturers in Germany. Our conclusions are valid only for maize-sugar as furnished by manufacturers in this country.

It should be further remarked that, although our experiments show conclusively that the products of fermentation of glucose are not dangerous to health, it does not necessarily follow that beer made by the fermentations of glucose is just as good as that made in the usual way. That is a matter which does not fall within the scope of our investigation.

V.—SUMMARY AND CONCLUSION.

The results which have been obtained by the committee, and which have been presented in the foregoing pages, may be briefly summed up as follows:

1st. Starch-sugar as found in commerce is a mixture, in varying proportions, of two sugars, called dextrose and maltose, and of dextrine, or starch-gum. Dextrose was discovered in grapes by Lowitz, in 1792, and was first prepared from starch by Kirchhoff, in 1811. In 1819, Braconnot prepared it from woody fibre. Maltose was first recognized as a distinct sugar by Dubrunfaut, in 1847, in the product of the action of malt on starch. No dextrose is thus produced, according to O'Sullivan.

2d. The process of making starch-sugar consists, first, in separating the starch from the corn by soaking, grinding, straining, and settling; and second, in converting the starch into sugar by the action of dilute sulphuric acid, this acid being subsequently removed by the action of chalk. To make the solid, "grape-sugar," the conversion is carried further than to make the liquid, "glucose." After clarifying, the liquid is concentrated in vacuum-pans and is decolorized with bone-black.

3d. The starch-sugar industry in the United States gives employment to twenty-nine factories, having an estimated capital of five millions of dollars, consuming about forty thousand bushels of corn per day, and producing grape-sugar and glucose of the annual value of nearly ten millions of dollars. In Germany, in 1881–'82, there were thirty-nine factories of this sort, consuming over seventy thousand tons of starch, and producing about forty thousand tons of starch-sugar.

4th. Starch-sugar is chiefly used in making table-sirup, in brewing beer as a substitute for malt, and in adulterating cane-sugar. It is also

used to replace cane-sugar in confectionery, in canning fruits, in making fruit-jellies, and in cooking. Artificial honey is made with it; and so, also, is vinegar.

5th. Starch-sugar represents one distinct class of sugars, as cane-sugar does the other; the former being obtained naturally from the grape, as the latter is from the cane and the beet. Starch-sugar, which is a term chemically synonymous with dextrose and glucose, when pure, has about two-thirds the sweetening power of cane-sugar. By the action of the dilute acids, both cane-sugar and starch yield dextrose. In the case of starch, however, dextrose constitutes the sole final product.

6th. The commercial samples of starch-sugar obtained by the committee showed a fairly uniform composition on analysis. The liquid form, or "glucose," contained from 34.3 to 42.8 per cent. of dextrose; from 0 to 19.3 per cent. of maltose; from 29.8 to 45.3 per cent. of dextrine, and from 14.2 to 22.6 per cent. of water. The solid form, "grape-sugar," gave from 72 to 73.4 per cent. of dextrose; from 0 to 3.6 per cent. of maltose; from 4.2 to 9.1 per cent. of dextrine, and from 14 to 17.6 per cent. of water. Three specimens of especially prepared "grape-sugar" contained 87.1, 93.2, and 99.4 per cent. of dextrose, respectively. The last of these was crystalline anhydrous dextrose.

7th. Of mineral or inorganic constituents, the samples of starch-sugar examined contained only minute quantities. The total ash formed in the "glucose" was only from 0.325 to 1.060 per cent., and in the "grape-sugars," only from 0.335 to 0.750 per cent. No impurities, either organic or inorganic in character, other than those mentioned, were detected in any of the samples examined.

8th. The elaborate experiments upon the fermentation of starch-sugar would seem to be final on the question of the healthfulness, not only of glucose itself, but also of the substances produced by the action of a ferment upon it. Large quantities of a concentrated extract from the fermentation, representing from one-third to one-half a pound of starch-sugar, were taken internally by the experimenter, and this repeatedly, without the slightest observable effect. This result, rigidly applied, holds of course only for those sugars which, like this, are made from the starch of Indian corn, or maize.

In conclusion, then, the following facts appear as the result of the present investigation: First, that the manufacture of sugar from starch is a long-established industry, scientifically valuable and commercially important; second, that the processes which it employs at the present time are unobjectionable in their character, and leave the product un-

contaminated; third, that the starch-sugar thus made and sent into commerce is of exceptional purity and uniformity of composition, and contains no injurious substances; and fourth, that though having at best only about two-thirds the sweetening power of cane-sugar, yet starch-sugar is in no way inferior to cane-sugar in healthfulness, there being no evidence before the committee that maize-starch sugar, either in its normal condition or fermented, has any deleterious effect upon the system, even when taken in large quantities.

All of which is respectfully submitted.

GEORGE F. BARKER, Chairman,
WILLIAM H. BREWER,
WOLCOTT GIBBS,
CHARLES F. CHANDLER,
IRA REMSEN,

Committee.

APPENDIX.

APPENDIX A.

BALTIMORE, 1882.

SIR: At the request of the Commissioner of Internal Revenue of the United States, the undersigned have been appointed a committee of the National Academy of Sciences for the purpose of making a scientific investigation of the various products which are obtained from starch, and known as glucose, grape-sugar, maltose, &c., and of the processes used in their manufacture.

While giving full weight to the investigations which have already been made, the committee feel that it is desirable for them to reach their conclusions, as far as possible, independently, and hence they have decided to ask the assistance of the manufacturers in getting together the necessary information, and in taking samples of products for examination. As the investigation is in the interests of the manufacturers as well as of the public, we respectfully request that, as soon as convenient, you will forward to the secretary answers to the questions to be found on the next page.

It is of course understood that, without special permission from you, no use will be made of the information you may give us, except in a general way, and without mention of the name of your firm.

Yours, respectfully,

G. F. BARKER, Chairman,
Professor University of Pennsylvania, Philadelphia, Pa.

W. H. BREWER,
Professor Yale College, New Haven, Conn.

C. F. CHANDLER,
Professor Columbia College, New York, N. Y.

WOLCOTT GIBBS,
Professor Harvard College, Cambridge, Mass.

IRA REMSEN, Secretary,
Professor Johns Hopkins University, Baltimore, Md.

1. Please give as full a description as you may care to of the processes used in your factory. (Descriptions of machinery would not be of much use to the committee.)

2. What are the names and general properties of the products which your firm places on the market?

3. Will you give an agent authorized by us the privilege of taking samples of your products at your factory?

4. What information can you furnish regarding the capacity of your establishment, as shown by the consumption of raw material in 1881 and 1882? Is any other material used besides corn?

5. What is the principal use made of your products?

6. Please add the names and addresses of any firms known to you, and not included in the accompanying list.

APPENDIX B.

The glucose and grape-sugar factories of the United States.

Location of factory.	Name of factory.	Name of firm.	Office of firm.
Illinois—			
*Champaign	Champaign Grape-Sugar Company.	Champaign Grape-Sugar Company, Mr. Smith, president.	Champaign, Ill.
*Chicago	Eberts'	Eberts'	Chicago, Ill.
*Chicago	Chicago Sugar-Refining Company.	Chicago Sugar-Refining Company.	Chicago, Ill.
*Danville	Danville Refining and Starch Works.		Danville, Ill.
*Freeport	Veiller, Jayne & Co	Veiller, Jayne & Co	Freeport, Ill.
*Geneva	Geneva Grape-Sugar Company.	Geneva Grape-Sugar Company.	Geneva, Kane county, Ill.
*Gladstone	Gladstone Refinery Sugar Company.	Gladstone Refinery Sugar Company.	Gladstone, Ill.
*Pekin	Richard & Gill	Richard & Gill	Pekin, Ill.
*Peoria	Peoria Grape-Sugar Company.	Peoria Grape-Sugar Company.	Peoria, Ill.
Peoria	Peoria Sugar-Refinery	Peoria Sugar-Refinery, C. J. Hamlin, presd't.	No. 19 W. Swan street, Buffalo, N. Y.
*Rockford	Rockford Grape-Sugar Company.	Rockford Grape-Sugar Company.	Rockford, Ill.
*Sagetown			Sagetown, Ill.
Iowa—			
*Davenport	Davenport Glucose Manufacturing Company.	Davenport Glucose Manufacturing Company.	Davenport, Iowa.
*Des Moines	Des Moines Sirup Refinery.	Des Moines Sirup Refinery.	Des Moines, Iowa.
*Iowa City	Iowa City Grape-Sugar Company.	Iowa City Grape-Sugar Company.	Iowa City, Iowa.
*Marshalltown	Grape-Sugar Company	Grape-Sugar Company	Marshalltown, Iowa.
Kansas—			
Atchison			Atchison, Kans.
Leavenworth	Leavenworth Sugar Company.	Leavenworth Sugar Company, C. J. Hamlin, president.	No. 19 W. Swan street, Buffalo, N. Y.
Michigan—			
*Detroit	Michigan Sugar Company.	D. H. Howell, Sons & Co., agents.	Agents' office, 107 Wall street, New York.
Missouri—			
*Kansas City	Rochester Grape-Sugar Company.	Rochester Grape-Sugar Company.	Kansas City, Mo.
St. Joseph	St. Joseph Refining Company.	St. Joseph Refining Company.	St. Joseph, Mo.
*St. Louis	St. Louis Sirup, Glucose, and Grape-Sugar Company.	St. Louis Sirup, Glucose, and Grape-Sugar Company.	St. Louis, Mo.
Nebraska—			
Omaha			Omaha, Nebr.
New York—			
*Buffalo, Scott street and Hamburg canal.	American Grape-Sugar Company.	American Grape-Sugar Company, C. J. Hamlin, president.	No. 19 W. Swan street, Buffalo, N. Y.
*Buffalo, Court street.	Buffalo Grape-Sugar Company.	Buffalo Grape-Sugar Company, C. J. Hamlin, president.	No. 19 W. Swan street, Buffalo, N. Y.
*East Buffalo, Jefferson street, near William.	The Firmenich Sugar-Refinery Company.	The Firmenich Sugar-Refinery Company.	No. 22 W. Seneca street, Buffalo, N. Y.
*Glen Cove, Long Island.	Glen Cove Manufacturing Company.	Glen Cove Manufacturing Company.	298 South street, New York city.
*New York city, 132 King street.	Booth & Edgar's	Booth & Edgar	100 Wall street, New York city.
421 W. Fifteenth street.	Manhattan Sugar Company, (Limited.)	Manhattan Sugar Company, (Limited.)	421 W. Fifteenth street, New York city.
Ohio—			
*Tippecanoe City	Grape-Sugar Company	Grape-Sugar Company	Tippecanoe, Miami county, Ohio.
Toledo			
West Virginia—			
Wheeling	Fell's Sirup Factory	Fell	Wheeling, W. Va.

In response to this circular, very full communications were received from the following manufacturers:

J. A. Cunningham, Danville Refining and Starch Works, Danville, Ill.

George Turner, secretary and treasurer Geneva Grape-Sugar Company, Geneva, Ill.

W. H. H. Ammack, superintendent Gladstone Grape-Sugar Company, Gladstone, Ill.

Dr. F. H. Kimball, chemist Rockford Grape-Sugar Company, Rockford, Ill.

Louis P. Best, superintendent Davenport Glucose Manufacturing Company, Davenport, Iowa.

H. B. Leavens, secretary Des Moines Sirup Refinery, Des Moines, Iowa.

W. J. Allen, superintendent Iowa City Grape-Sugar Company, Iowa City, Iowa.

J. D. Hayes, vice-president Michigan Grape-Sugar Company, Detroit, Mich.

George B. Emmons, president St. Louis Sirup, Glucose, and Grape-Sugar Company, St. Louis, Mo.

The Firmenich Sugar-Refining Company, Buffalo, N. Y.

Harry Hamlin, vice-president Buffalo Grape-Sugar Company, Buffalo, N. Y.; vice-president American Grape-Sugar Company, Buffalo, N. Y.; vice-president Peoria Sugar-Refining Company, Peoria, Ill.; and vice-president Leavenworth Sugar Company, Leavenworth, Kans.

Hiram Duryea, vice-president Glen Cove Manufacturing Company, Glen Clove, N. Y.

Augustus Talbot, Manhattan Sugar Company, (Limited,) New York.

The Grape-Sugar Company, Tippecanoe City, Ohio.

A. G. Fell, Fell's Sirup Factory, Wheeling, W. Va.

Valuable information was also received from the following:

Arno Behr, Ph. D., Chicago, Ill.

Waldron Shapleigh, Freeport, Ill.

Albert L. Colby, Ph. B., inspector New York State board of health.

S. D. Phelps, New York.

Edgar Tucker, New York.

APPENDIX C.

EXAMINATION OF COMMERCIAL SUGARS WITH REFERENCE TO THEIR ADULTERATION WITH STARCH-SUGAR.

A.—Analyses of sugars purchased in open market.

Sixteen samples of brown sugars were bought in the open market at various groceries. Four of these were found to contain about 30 per cent. of grape-sugar. It is impossible to determine with accuracy the amount of grape-sugar present in a sample of adulterated cane-sugar, for the reason that the brown cane-sugars always contain invert sugar, which gives reactions identical with those of grape-sugar. The amount of invert sugar present varies, but may reach as much as 5 per cent., and perhaps more. If, however, in examining a specimen of cane-sugar, there should be found evidence of the presence of, say, from 20 to 30 per cent. of a sugar giving the reactions of grape-sugar, the conclusion would certainly be justified that the latter had been added.

In our examinations, the first test applied in every case was the treatment of the sample with lukewarm water. If no grape-sugar is present, the sample dissolves up quickly; if it is present in considerable quantity, there remains behind for some time undissolved a quantity of matter consisting of white, chalky-looking particles.

For the purpose of estimating the quantity of grape-sugar present in the adulterated samples, two methods were used:

1. The well-known method of Fehling, with the precautions and modifications suggested by Allihn, (Journal für Praktische Chemie, vol. 130, p. 46;) and

2. The method of Sachsse, modified as directed by Heinrich. (Chemisches Centralblatt, 1878, p. 409.)

For the Fehling-Allihn method, dissolve 173 grams sodium-potassium tartrate and 125 grams potassium hydrate in water, and dilute so as to make 500 C. C. Also dissolve 34.6 grams copper sulphate in water, and make up to 500 C. C. Keep the two solutions separate, and only bring them together when needed for immediate use.

For a determination, 30 C. C. of each of the solutions are brought together, and 60 C. C. water added. The whole is then heated to boiling. 25 C. C. of a sugar solution are then added, which must not contain

more than 1 per cent. sugar, and the whole heated on a water-bath for fifteen minutes. The precipitate is collected in an asbestos filter, washed with alcohol and ether, and a current of dry air drawn through. When dry, the suboxide of copper is reduced to copper in a current of hydrogen. The whole filter, (tube and asbestos,) together with the copper, is now weighed, and the weight of the copper found by deducting the weight of the filter, previously taken. The weight of sugar corresponding to the weight of copper found can be taken from Allihn's table. (Loc. Cit., pp. 63–65.)

For the preparation of the Sachsse-Heinrich solution, 18 grams pure mercuric iodide, 25 grams potassium iodide, and 10 grams potassium hydrate are dissolved in water, and the volume made up to 1 litre. The proportion of potassium hydrate here used is much smaller than that used by Sachsse, which was 80 grams. A portion of the solution prepared in the above way boiled for thirty minutes with 20 per cent. solution of pure cane-sugar failed to give the slightest evidence of the reduction of the mercuric iodide. 40 C. C. of this solution were found by titration with standard solutions of pure grape-sugar and invert sugar to correspond to 0.128 gram dextrose and 0.119 gram invert sugar.

Twelve of the sixteen samples collected did not contain more than 5 per cent. of sugar having an action in the solutions employed in the examination. Some of the details of the analysis of one of the adulterated samples and the figures obtained in the analyses of two other adulterated samples are here given.

Sample 1.—Ten grams of the sample were dissolved in 100 C. C. distilled water; 10 grams of this solution were then diluted up to 100 C. C., so that in the weaker solution there was 1 gram of the substance in 100 C. C. of the solution. The amount of this solution necessary to reduce 40 C. C. of the previously standardized solution of mercuric iodide was now determined. It was found to be 39.3 C. C. But 40 C. C. of the mercuric iodide solution are equivalent to 0.128 gram of dextrose, (pure grape-sugar.) Therefore, in 0.393 gram of the sample there is 0.128 gram dextrose, an amount which corresponds to 32.8 per cent. This conclusively shows that the sample contained somewhere in the neighborhood of 30 per cent. of grape-sugar.

This result was confirmed by the aid of the Fehling-Allihn method. 10 C. C. of the same sugar solution as that used in the preceding estimation were added to 60 C. C. of Fehling's solution. The cuprous oxide was collected on an asbestos filter, reduced to metallic copper, and weighed. The weight of copper thus found was 0.0633 gram. This corresponds to 0.03235 gram dextrose, (grape-sugar,) or in 0.1

gram of the sample there was 0.03235 gram of grape-sugar. This is 32.35 per cent. of the whole, while by the Sachsse-Heinrich method the amount found was 32.8 per cent.

In *Sample* 2 the Sachsse-Heinrich method indicated the presence of 33.6 per cent. of dextrose, while the Fehling-Allihn method gave 33.8 per cent.

In *Sample* 3 the former method gave 26.3 per cent., and the latter 26.9 per cent. dextrose.

A further sample gave results similar to those just described, and was undoubtedly adulterated.

While the figures given cannot be regarded as accurate, they show beyond a doubt that the samples examined were largely adulterated. Whether the amount of grape-sugar present is exactly stated or not, there was certainly present as much as 20 per cent., and probably somewhere between 30 and 40 per cent. If the samples examined had consisted of pure cane-sugar mixed with pure grape-sugar, the figures obtained would have varied only very slightly from the truth. But in fact neither the cane-sugar nor the grape-sugar was pure, and we cannot tell what allowance to make for the impurities. There may have been as much as 5 per cent. of a reducing-sugar, like grape-sugar, in the cane-sugar originally used. There could hardly have been much more. Subtracting this amount (5 per cent.) from the total found in the first adulterated samples, there remain about 27 per cent. of reducing-sugar, which must have been intentionally added. But this figure represents only the amount of *reducing-sugar* added, and not the total quantity of substance added. Now, as has been shown in an earlier part of this report, the commoner grades of commercial grape-sugar contain only about 70 to 75 per cent. of reducing-sugar, so that in order to add to a cane-sugar 25 per cent. of a reducing-sugar, we should have to add a considerably larger amount of commercial grape-sugar, say about 33 per cent. Hence, it appears probable that the adulterated samples examined by us contained about 33 per cent. of grape-sugar.

B.—Extracts from board of health reports.

Extract from the report of A. L. Colby, Ph. B., to the sanitary committee of the New York State board of health in 1881.—(*Second annual report of the board, p.* 604.)

Although, as we have just seen, the sugars of to-day are free from insoluble mineral adulterations, the use of glucose as an adulterant is practiced to a considerable extent. The result of the examination of

the one hundred and sixteen samples for the presence of artificial or added grape-sugar, or glucose, is given in the following table:

Grade of sugar.	No. examined.	Unadulterated.	Adulterated with glucose.
Cut loaf	7	7	.....
Granulated	4	4	.....
"A"	5	5	.....
Powdered	33	33	.....
Light-brown, "Extra C"	49	46	3
Brown, "C"	10	9	1
Dark-brown, "X"	8	8	.....
Total	116	112	4

This table shows that the white sugars are all unadulterated; but the brown sugar (especially the light-brown coffee-sugar, "Extra C") is the variety in which this sophistication is practised. As the table shows, of the sixty-seven samples examined, four were found adulterated. and to a large extent, as may be seen by the following analyses:

No. of sample.	Character of sugar.	Per cent. of added glucose.	Per cent. of total glucose.
705	Brown, "C"	22.20	(*)
706	Light-brown, "Extra C"	21.24	26.522
707	Light-brown, "Extra C"	29.79	32.834
708	Light-brown, "Extra C"	33.36	35.878

* Undetermined.

All colored sugars contain more or less "fruit" or "invert" sugar, which is a mixture of equal parts of dextro-glucose and levo-glucose. This is produced from the cane-sugar in the process of manufacture. The artificial glucose, used as an adulterant, is dextro-glucose made from starch.

These so-called "mixed sugars" are sold in the wholesale market under certain trade-names, such as "New Process Sugar," "Niagara A, B, C," "Harlem B," "Excelsior C," &c., which signify to the purchaser their character. They are, however, usually disposed of in the retail trade as pure sugars. As most of these "mixed sugars" are sent to the country, they are rarely to be found in the hands of retail city grocers.

A review of other recent investigations of sugar proves the general use of glucose as an adulterant. From the six annual reports on the

adulteration of food in Canada* the following tabular statement of the results has been compiled:

Sugars analyzed.

Date of report.	Number of sugars analyzed.	Genuine.	Adulterated with glucose.	Doubtful.
First report, 1876	15	12	3	.....
Second report, 1877	34	30	4	.....
Third report, 1878	42	34	8	.....
Fourth report, 1879	101	81	9	11
Fifth report, 1880	55	55	.....	.....
Sixth report, 1881	63	63	.....	.....
Total	310	275	24	11

An investigation of seventy-five samples of sugar, made in 1879 by the Massachusetts State board of health, lunacy, and charity,† shows the presence of an undue excess of glucose in three cases.

"The recent investigation of sugars made by Dr. Charles Smart, under the direction of the National Board of Health,‡ shows the very general use of glucose as an adulterant. "Among forty-seven brown sugars, most of which were furnished by dealers who knew that their samples would be examined, there were found three which contained glucose, while among thirty-eight samples purchased for analysis no less than nine were thus adulterated. The glucose varied from a small admixture to 30 per cent."

*Report on the adulteration of food, being Supplement No. 111 to the Report of the Department of Inland Revenue.

†First Annual Report State Board of Health, Lunacy, and Charity of Massachusetts, 1879, p. 60.

‡National Board of Health Bulletin, Supplement No. 6, January 1, 1881.

APPENDIX D.

EXTRACTS FROM THE JOURNAL LITERATURE RELATING TO STARCH-SUGAR, CHRONOLOGICALLY ARRANGED; PREPARED BY E. J. HALLOCK, PH. D.

Kirchhoff's discovery of starch-sugar.

Professor John, (1812,) in Schweigg. J., iv, p. 111: The author learns, through Nasse, that Kirchhoff was trying to make a cheap gum, and produced sugar instead. From 100 lbs. starch, Nasse and Kirchhoff got 90 lbs. solid grape-like sugar, or 120 lbs. of very sweet sirup.

It is a peculiar kind of sugar, resembling grape-sugar, but better.

Nitric, hydrochloric, sulphuric, and oxalic acids produce it, but tartaric, acetic (?), and phosphoric do not.

Preparation of starch-sugar.

Schrader, (1812,) in Schweigg. J., iv, p. 108: Author repeated Kirchhoff's experiment. The latter employed 1 part acid and 400 of water to 100 of starch, and boiled 36 hours. Schrader used more acid, and boiled to 9 hours, and got a sweeter product. He compares the operation to the manufacture of ether.

Conversion of starch into sugar.

Pfaff, (1812,) in Schweigg. J., v, p. 94: Author repeated Kirchhoff's experiment in glass retorts, and found no CO_2 or SO_2 evolved; hence the conversion is not oxidation, nor does it resemble germination, which yields CO_2. He does not compare it with ether-making, because the circumstances differ. He calls it killing the starch, and compares it to potatoes, that get sweet under the influence of cold.

Conversion of starch into sugar.

Vogel, (1812,) in Schweigg. J., v, p. 80: The author first asserts that no chemist has yet made sugar by chemical means until Kirchhoff, in St. Petersburg, made a gummy and sugary substance by acting on starch with sulphuric acid.

The author repeated Kirchhoff's experiments, using 40 grams of acid in 8 kilograms of water (1–200) for 2 kilograms of starch. He obtained an equal weight of sirup containing varying quantities of sugar and

gum. The latter was insoluble in alcohol, but did not form gummic acid when acted on by nitric acid. He believes that the acid withdraws the elements of water from the starch. (See, also, Gilbert's Ann., xlii, p. 123.)

On the sweetness of starch-sugar.

Gehlen, (1812,) in Schweigg. J., v, p. 42: This author repeated Kirchhoff's experiment, and described the product as yellowish; soluble in $1\frac{1}{3}$ parts water; gives a white precipitate, with oxalates; none with H_2S, $(NH_4S)_2$, KCy, or tincture of galls. Only experience can tell whether it is wholesome; but probably it is so, (p. 41.) Does not form caramel when heated, and melts easily. In sweetening power, $2\frac{1}{4}$ or $2\frac{1}{2}$ equals 1 of cane-sugar. Its price must be proportionately lower than cane-sugar, to compete with it. The sirup irritates the throat like honey, which it closely resembles.

Was starch-sugar a French discovery?

De Gassicourt, (1812,) in Schweigg. J., v, Beilage Moniteur, No. 150: In 1801, Fourcroy obtained a sugary substance by passing chlorine into a solution of gum or starch suspended in water.

Parmentier, in his Pharmacopœia, p. 361, says he formed sugar from starch by the action of cream of tartar thirty years ago.

Schweigger adds a note that nearly upsets all this author says.

Action of the gluten in converting starch into sugar.

Kirchhoff, (1814,) in Schweigg. J., xiv, p. 389, (read in St. Petersburg Acad., Sept. 1, 1812:) The author deduces the following conclusions from his experiments:

1. Gluten causes the formation of sugar in germinated seed and in the meal which has been soaked in hot water.

2. The starch in germinated seed is unchanged, and is first converted into sugar (at a temperature above 40° R.) by the gluten.

3. The starch in the flour is to be considered as the best material for making alcohol.

4. In germination the gluten acquires the power of saccharifying more starch than the grain contains.

5. The production of sugar in germinated seeds is a chemical process, and not the result of vegetation.

6. In wort the starch is in the sweet form, and infusion of galls does not affect it.

Decomposition of starch by water.

Saussure, (1819,) Ann. Chem., Aug., 1819; Schweigg. J., xxvii, p. 320: When starch and water are exposed to a temperature of 20° or 25° C., with or without access of air, there are formed—

1. A kind of sugar similar to that made by the action of acid.
2. A kind of gum similar to roasted starch.
3. A substance here called "amidin," between gum and starch in properties.
4. A substance as insoluble in boiling water and several acids as woody fibre, but is blued by iodine.

Also other products.

Sugar from old linen.

Braconnot, (1819,) Ann. Chim. Phys., Oct., 1819, p. 172; Schweigg. J., xxvii, p. 337: Twenty-four grams old dried linen was first converted into gum by 34 grams sulphuric acid, diluted, the unchanged fibre (3.6 grams) filtered out, then boiled two hours, and saturated with carbonate of lime. Basic acetate of lead gave no precipitate. The solution was evaporated and heated until it smelled of burnt sugar. Yield was 23.3 grams from 20.4 of linen. It was diluted to a sirup, and in 24 hours began to crystallize. It has a pleasant, pure, and rather cooling taste. It is capable of fermentation.

Conversion of cane-sugar by pectine.

Le Roy, (1832,) Ann. Ch. Pharm., viii, p. 207; J. de Chim. Méd., viii, p. 597: Author boiled the juice of ripe currants, apricots, strawberries, &c., before fermentation, with 1½ parts of cane-sugar; in a few months the sugar was all converted into grape-sugar. This was not the case when the juice had fermented beforehand.

Chevallier had already made a similar observation.

Le Roy's experiments go to prove that the inversion is caused by the pectine.

Products formed from starch by diastase.

Payen and Persoz, (1833,) Ann. Chim. Phys., (2,) liii, p. 73: The starch is entirely changed into two bodies—an uncrystallizable sugar and a gum—the sum of whose weights equals that of the starch.

Beer from starch-sugar.

Lampadius, (1833,) J. Tech. Ch., xvi, p. 374; Pharm. Centrl., (1833,) p. 351: Author prepared a very good beer from starch-sugar with extract of hops, yeast, and some white of egg. After lying three weeks, it was clear, sparkling, and of very pleasant flavor.

Preparation by means of diastase.

W. A. Lampadius, (1834,) in J. Pr. Ch., ii, p. 457: Four lbs. potato-starch and 24 lbs. water boiled to a paste in a tinned copper cylinder. Kept ten hours at 42° to 47° R., after putting in ½ lb. of barley-malt, coarsely ground in a coffee-mill. No change, as the malt was five weeks old. With fresh malt, the paste became a thin liquid in ten minutes, but not very sweet, but sweetness increased for eight hours. No blue color with starch. Yield of 4 lbs. 13 loth of transparent sirup; specific gravity, 1.280. In taste it differs somewhat from that made with sulphuric acid.

Sugar obtained from starch by means of diastase.

Guérin-Varry, (1835,) Ann. Chim. Phys., (2,) lx, p. 54: It is white, odorless, less sweet than cane-sugar, crystallizes in cauliflower crystals; specific gravity, 1.38 to 1.6. Heated for an hour at 100° C., loses 9.8 per cent. of its weight of water. At 23.5° C., 63¼ parts dissolve in 100 of water. Is a little less soluble than grape-sugar; 100 parts yields 42.288 of CO_2 and 44.28 of alcohol.

That made by the action of acids has the same composition as that made by diastase and as grape-sugar.

Composition and preparation of starch-sugar.

C. Brunner, (1835,) Pogg. Ann., xxxiv, p. 319; Ann. Ch. Pharm., xiv, p. 303: Author refers to the contradictory views of Saussure and Converchel, also Guérin, Guilbourt, Raspail, Biot, and Persoz.

Brunner's experiments gave for the composition of pure potato-starch:

	1.	2.	3.	Average.
C	44.373	44.672	43.242	44.095
H	6.316	6.360	6.756	6.477
O	49.311	48.968	50.002	49.428

From 100 parts of this starch he obtained 106.82, 108.30, 106.239, 106.711; average, 107.01 of dry sugar. He then made the NaCl compound, and found an average of 13.522 per cent. NaCl. Calloud found 8.3 per cent. in that made from urine-sugar, 25 per cent. in that from grape-sugar.

Manufacture of starch-sugar.

Bouchardat, (1836,) in J. Pr. Ch., vii, p. 83: 1. It is better to use but little acid and let it act a long time, until alcohol gives no precipitate.

2. Must saturate at once when done.
3. Steam better than open fire.
4. Avoid too much lime, as it blackens and destroys the sugar. The best char in that from Prussian-blue factories.

Manna-sugar in starch-sugar.

Frémy, (1836,) in L'Institute, (abst. in J. Pr. Ch., viii, p. 197:) Frémy prepared the starch-sugar with care in the usual manner, crystallized it once, and treated it with alcohol.

From the solution he obtained manna-sugar in crystals; hence, it is not a product of fermentation, but, being infermentescible, remains in the fermented sirup.

Mannite from starch-sugar.

Frémy, (1836,) Inst. Pharm. Centrl., (1836,) p. 686: Author obtained mannite by treating a starch-sugar (made with sulphuric acid) with alchohol. Hence it is present in the starch-sugar, and not formed from it by fermentation. Being incapable of fermenting, it remains unchanged in fermented liquors.

Cost and value of starch-sugar.

J. Pr. Ch., (1837,) xi, p. 185: A "wispel" of potatoes makes 500 lbs. of green starch; 250 lbs. of this starch will make 1 cwt. of dry sugar, worth in Berlin 13 or 14 thalers, ($10.50.)

The waste is used for fodder, and covers the expense of fuel, labor, &c.

Starch-sugar is used by bakers and brewers and to improve wines, to make artificial wines and liquors, and the cost of manufacture is 4 groschen 3 pfennige per 100 lbs. of potatoes. One hundred pounds of potatoes are worth 16 to 18 groschen, (40 to 45 cents.)

Formula for starch-sugar.

Péligot, (1838,) C. R., vi, p. 232; J. Pr. Ch., xiii, p. 380, and xiv, p. 84: He made a barium, lead, and NaCl. compound, and deduced these formulas:

Crystallized sugar ..... $C_{48}H_{42}O_{21}, 7H_2O$.
Sugar, dried at 100° C ..... $C_{48}H_{42}O_{21}, 3H_2O$.
Saccharate of baryta ..... $C_{48}H_{42}O_{21}, 3BaO, 7H_2O$.
Saccharate of lead ..... $C_{48}H_{42}O_{21}, 6PbO$.
Salt and sugar ..... $C_{48}H_{42}O_{21}, Cl_2Na, 5H_2O$.
Salt and sugar, dried at 130° C ..... $C_{48}H_{42}O_{21}, Cl_2Na, 3H_2O$.

Decomposition of grape-sugar by peroxide of lead.

A. Stürenburg, (1839,) Ann. Ch. Pharm., xxix, p. 291: The oxide of lead was stirred into water, and heated to boiling; then the sugar added until the brown color had nearly disappeared. Carbonic acid was evolved, and an odor of formic acid noticed; carbonate of lead alone remained.

1 atom sugar forms 4 atoms water.

1 atom sugar forms 2 atoms CO_2.

1 atom sugar forms 2 atoms formic acid.

1 atom sugar forms 8 atoms plumbic oxide.

Cane-sugar suffered a similar change, but more slowly.

Action of concentrated sulphuric acid on starch-sugar.

Péligot, (1839,) Ann. Ch. Pharm., xxx, p. 78: If 1 part crystallized starch-sugar is melted in a water-bath and 1½ parts concentrated sulphuric acid added slowly, with cooling, an acid is formed which forms, with oxide of lead, a white salt. Author calls it "saccharo-sulphuric acid," (zuckerschwefelsäure.)

Digestion of starch.

J. Vogel, (1841,) Valentin's Rep., (1841,) p. 293; Pharm. Centrl., (1842,) p. 48: The author thinks that the fact observed by Leuchs and confirmed by Hünefeld, that saliva is able to convert starch into sugar, is of little consequence in digestion, because unchanged starch is often present in the stomachs of men and animals.

Fermentability of the sugars.

H. Rose, (1841,) Pogg. Ann., lii, p. 293; Ann. Ch. Pharm., xl, p. 324: If equal weights of cane and grape sugar are dissolved in equal parts of distilled water, and small but equal quantities of yeast added at 20° C., the former begins to ferment at once, and in a few days it is finished. The latter can be kept for months at 25° or 30° C. To bring both into equal fermentation, seven or eight times as much yeast must be put in the cane-sugar solution, as the excess is required to convert it into grape-sugar. Grape-sugar is the only directly fermentescible substance, and cane-sugar is more easily converted into grape-sugar than any other vegetable substance, and this is best accomplished by tartaric acid or argol.

Optical properties of sugars.

Ventzke, (1842,) J. Pr. Ch., xxv, p. 65: Describes his polarizing apparatus (ill.) and its uses:

Fruit-sugar (uncrystallizable sugar) always turns to the left. It is found in sweet fruits (grapes) and honey, and is formed from other sugars

by acids; from cane-sugar (and probably milk-sugar) by the action of ferments.

Grape-sugar, in urine, in solid honey, action of acid or diastase on amylon, acids on cane-sugar, in many sweet fruits.

A table is given for ten sugars, showing the rotation in tube 234 mm. long.

Influence of water and heat on sugar.

Soubeiran, (1842,) Jour. de Pharm., 1842, pp. 1 and 89; J. Pr. Chem., xxvii, p. 298: His experiments proved the stability of crystallized grape-sugar under the influence of water and heat and of acetic acid, but it is easily decomposed by alkalies.

Uncrystallizable (inverted) sugar is decomposed by acetic acid and by alkali.

Optical tests employed.

Glucose fermentation.

Bouchardat, (1845,) Ann. Chim. Phys.; Ann. Ch. Pharm., lix, p. 80: Diastase acts most powerfully on starch-paste, but is not the only thing which will convert starch into dextrine and glucose. He gives a list of these substances, such as yeast, germinated grain, membranes, &c.

Effect of reagents on the action of diastase: Nitric, sulphuric, phosphoric, hydrochloric, oxalic, tartaric, and citric acids prevent the action of diastase entirely. Fixed alkalies also prevent it; also chlorine and bromine. Sulphate and acetate of copper and corrosive sublimate prevent; calomel not. Neutral chlorides of calcium, barium, stronium, and ammonium do not. Sulphate, acetate, borate, phosphate, and iodide slightly check it. Alkaloids have little influence. Alcohol, ether, essential oils, and creosote have no effect.

Conversion of cane-sugar into a substance isomeric with cellulose.

Tilley and Maclagan, (1846,) Phil. Mag.; Ann. Ch. Pharm., lx, p. 263: When the mixture of sugar, water, tartaric acid, and ethereal oils used for lemonade stands a long time, it forms a thick, sticky substance, of the same composition as cellulose.

On glucose, (maltose.)

Dubrunfaut, (1847,) Ann. Chim. Ph., xxi, p. 178; J. Pr. Ch., (1847,) xlii, p. 425: Dumas gives this name to different sugar-like products that crystallize in worts. Those from fruit, honey, or diabetic urine, or made by the action of acid on starch or wood fibre, are identical.

When made by the action of malt on starch, it has a greater rotatory power. It seems to crystallize in rhombohedra, is less soluble in alcohol, and less affected by alkalies. It is converted into glucose by boiling with acids.

Glucose.

Dubrunfaut, (1847,) Ann. Chim. Phys., xxi, p. 178; Dingl. J., cvii, p. 358: Glucose made by action of malt on starch is less soluble than that from grapes, and less affected by boiling with water or alkali. Its rotatory power is three times as great, but changes with time. If boiled long enough with sulphuric acid, it forms a sugar identical with grape-sugar. It is the first product of the action of acids on starch, and the end product of the action of glutinous nitrogenous materials.

Jacquelin and Biot's starch-sugar with double rotation is a mixture of two kinds of glucose with single and triple rotation.

Detection of starch-sugar in cane-sugar.

Chevallier, (1848,) J. Chim. Méd., March, 1848; Dingl. J., cviii, p. 319: Twenty grams water; 10 grams sugar; 0.5 gram caustic potash. Heat in a porcelain dish on the open fire. Cane-sugar turns greenish-yellow; mixed sugar turns coffee-brown.

Detection of adulterations of sugar with glucose.

Reich, (1848,) J. Pr. Ch., xliii, p. 71: Evaporate and add concentrated H_2SO_4 in slight excess; filter; add $BaCO_3$; filter, and if dilute H_2SO_4 gives a precipitate, there was sulpho-saccharic acid formed.

Another test is potassium bichromate, also cobaltic nitrate.

Composition of honey.

Soubeiran, (1849,) J. Pharm. Chim., xvi, p. 252; J. Pr. Ch., xlix, p. 65: Honey consists of three kinds of sugar. The first is krümel-sugar; the second is a liquid sugar, similar to that made by the action of acid on cane-sugar, but has nearly twice its rotatory power to the left; the third can be inverted, but turns light to the right.

Invert sugar, honey, and raisins.

Dubrunfaut, (1849,) C. R., xxix, p. 51; Dingl. J., cxiii, p. 387: 1. Sugar made from cane-sugar by acids or ferment is a mixture of equal equivalents of crytallizable grape-sugar, $C_{12}H_{12}O_{12}$, and an uncrystallizable sugar of the same composition rotates to the left, &c.

2. Honey, when fresh, contains varying quantities of cane-sugar, all being in the liquid part; it disappears in time under the action of a

natural ferment. Characteristic flavor, due to substances developed by the alcoholic fermentation. Contains 20 to 30 per cent. glucose. Every honey contains a large quantity of fruit-sugar, also an excess of glucose or other dextro-rotatory sugar. Its purgative properties are due to the liquid sugar.

3. The dextro-grape sugar on raisins is due to decomposition of the fruit-sugar, from fermentation, insects, &c.

Action of water on sugar.

Maumené, (1854,) C. R., xxxix, p. 422; Dingl. J., cxxxv, p. 59: 1. The purest cane-sugar dissolved in pure water is gradually changed into uncrystallizable sugar, even in the cold.

2. Heat favors this change.

3. Glucose and gum suffer no change.

4. This change takes place in the beet itself.

5. Organic acids do not perceptibly aid it.

6. The effect of the water must be taken into account in the analysis of sirups, &c.

7. Soubeiran's table (C. R., p. —; Dingl. J., cxix, p. 146) cannot be employed.

8. Binoxide of potassium is not reliable. (Dingl. J., cxxv, p. 292.) Dextrine is not always present in commercial glucose.

9. Caustic potash is not infallible, for most sugars are browned by it.

10. Hence it is necessary to measure the actual quantity of crystallizable sugar by crystallizing over lime or sulphuric acid.

Fruit-sugar from vegetable matters.

Melsens, (1855,) Genie Ind., p. 106; Dingl. J., cxxxviii, p.426: The author uses leaves, straw, rags, chips, twigs, and residues from breweries, distilleries, &c., by heating in a lead-lined autoclane with water containing 2 to 5 per cent. of acid; also lets them soak in acidified or alkaline water previous to treatment, or lets them putrefy, as in the old way of making paper.

Adulterated glucose.

L. Gall, (1856,) Polyt. Notiz., No. 4; Dingl. J., cxxxix, p. 468: Author says that there was in the market a sort of grape-sugar, sold at 8 thalers per cwt., for "improving wine," which imparts to the wine a bad taste.

Test: Dissolve in warm water; then cover the vessel and boil. On removing the cover a vile odor is noticed. Pure glucose gives no odor.

On the use of the word glucose.

Biot, (1856,) C. R., xlii, p. 351; J. Pr. Ch., lxviii, p. 429: This word was originally used for starch-sugar only, and should not be applied to all solid sugars, or to subjects differing in chemical, physical, and crystallographic properties. Three different sugars made from starch:

No. 1. Rotatory power of 51.13 right.

No. 2. Rotatory power of 1.54 right.

No. 3. Rotatory power of 100.57 right.

Change in the rotatory power of glucose.

Béchamp, (1856,) C. R., xlii, p. 896; J. Pr. Ch., lxix, p. 433: The change is attributed to a gradual conversion of crystallized into uncrystallizable sugar. He also concludes that there are two definite modifications of anhydrous starch-sugar, $C_{12}H_{12}O_{12}$. One of these melts easily at 100° C., and has a rotation of nearly 57.3°, which is unchangeable. The other does not melt at 100° C., but has a variable rotation, which tends to approach (with time) 57.3°.

Conversion of mannite and of glycerine into a true sugar.

Berthelot, (1857,) C. R., xliv, p. 1002; J. Pr. Ch., lxxi, p. 507: Various substances will produce this change, but only one will do so regularly at all times, viz., the membrane of a testicle, (man, cock, dog, or stallion.) Formation of *pencillium glaucum* is a hinderance.

Action of water on cane-sugar.

Béchamp, (1858,) C. R., xlvi, p. 44; Dingl. J., cxlix, p. 207: A solution of cane-sugar in pure water kept seventeen months, and changed from 22° to 1.5° in rotatory power, and mould formed. When creosote or corrosive sublimate was added, it lost none of its rotatory power. A solution in boiled distilled water, protected from the air, suffered no change.

Cold water alone cannot invert cane-sugar; the conversion is due to a sort of fermentation.

Preparation and properties of glucose.

E. F. Anthon, (1859,) Dingl. J., cli, p. 213: 1. *Percentage of water.*—Anhydrous glucose dried at 100° C. is $C_{12}H_{12}O_{12}$; ordinary air-dried (krümelized) is $C_{12}H_{12}O_{12}+2HO$. Author has prepared hard crystallized glucose which contains $C_{12}H_{12}O_{12}+HO$.

2. *Solubility in water.*—One hundred parts of water dissolves 81.68 parts of the anhydrous sugar at 15° C.; or 89.36 parts of the sugar with

one molecule water, or 97.85 parts of the sugar with two molecules water of crystallization.

3. *Action of acid on starch.*—Not all the starch has been converted into glucose when the iodine and alcohol tests give no reaction; there is no time when there is nothing but grape-sugar in solution.

4. *On the purity of commercial grape-sugar and its tests.*—Author determined percentage of foreign matter by the specific gravity of the saturated solutions, and gives table.

Grape-sugar from woody fibre and cellulose.

J. Pelouze, C. R., (Feb., 1859;) Dingl. J., cli, p. 394: Author found that when wood fibre is boiled a long time in water, acidified with hydrochloric or sulphuric acids, it is converted into sugar. Paper, old linen, sawdust, &c., are also converted into sugar.

Sugar from glycogen of the liver.

Berthelot and De Luca, (1859,) C. R., xlix, p. 213; J. Pr. Ch., lxxxi, p. 188: The sugar was made by the action of dilute HCl on glycogen from a rabbit's liver. It was combined with NaCl to form—

$$2C_{12}H_{12}O_{12}2HO,\ NaCl,$$

which is identical with that which grape-sugar forms.

On the conversion of starch into grape-sugar and dextrine.

F. Musculus, (1860,) Ann. Chim. Phys., (3,) lx, p. 203; Dingl. J., clviii, p. 424: 1. Diastase has no action on dextrine.

2. Grape-sugar and dextrine appear simultaneously and in constant proportions, 1:2.

3. Dilute acid acts like diastase.

4. Here, too, dextrine and grape-sugar both appear together.

Conversion of amylaceous substances into glucose and dextrine.

F. Musculus, (1860,) C. R., l., p. 785; J. Pr. Ch., lxxxv, p, 243: Author does not think the starch is first converted by dilute acid into dextrine and then hydrated to form glucose.

1. Diastase does not act on dextrine.

2. Glucose and dextrine appear simultaneously, and always in the same relative proportions, 2:1.

3. At first diastase acts like dilute acid, but its action continues after the starch has disappeared, but acts very slowly then.

4. Dextrine and glucose appear in the same proportions, whether diastase or glucose is used:

First. After iodine produces no blue color, and alcohol no precipitate, there is still unfermentable dextrine present in considerable amount.

Second. One minute's boiling with acid has no effect on dextrine, but inverts all the cane-sugar.

Third. A large quantity of starch passes into beer in the form of dextrine.

Fourth. There is great loss in making alcohol from grain by use of diastase, $= \frac{2}{3}$ loss.

Solubility of pure grape-sugar in alcohol.

E. F. Anthon, (1860,) Dingl. J., clv, p. 386: The sugar was perfectly pure, and contained but 0.2 per cent. of water. At 14° R. (= 17.5° C.) one part of sugar dissolves in 50.54 parts alcohol of 0.837 specific gravity, in 11.34 parts alcohol of 0.880, in 5.25 parts alcohol of 0.910, and in 2.07 parts of alcohol of 0.950.

The solubility is not proportional to the amount of water in the alcohol.

One hundred parts alcohol of 0.837 dissolves 21.7 sugar, and 100 parts alcohol of 0.880 dissolves 136.7 sugar at the boiling point.

One part sugar dissolves in 4.6 of alcohol at 0.837, and 1 part sugar dissolves in 0.73 of alcohol at 0.880 at the boiling point.

After standing six days, 2.9 parts sugar were held in solution by 100 of alcohol of 0.837, and 12.4 in solution by 100 of alcohol of 0.880.

On the sugar in acid fruits.

H. Buignet, (1860,) C. R., li, p. 894; J. Pr. Ch., lxxxvi, p. 493: Cane-sugar is usually present in acid fruits, and during the ripening is gradually inverted. In ripe fruits there is either a variable mixture, as in pine-apples, apricots, peaches, apples, pears, &c., or it consists entirely of invert sugar, as in figs, currants, and grapes. The cause of difference does not depend on the acidity, but seems to result from a nitrogenous body, that acts like a ferment.

Production of dextrine and glucose from starch.

A. Payen, (1861,) C. R., liii, p. 1217; Dingl. J., clxiv, p. 144: 1. Author obtained 51 to 83.6 per cent. glucose in 3½ to 5 hours with 3 per cent. sulphuric acid.

2. Obtained 84 per cent. sugar from commercial dextrine under like conditions.

3. Hydrochloric acid more active than sulphuric, producing 62½ to 85½ per cent. glucose.

4. Fibre of wood yields glucose (hence, alcohol) and a fibre suitable for paper when treated with hydrochloric acid.

5. After the glucose had been removed from a mixture of the same with dextrine, the latter was easily saccharified by diastase.

6. Beer-yeast will not ferment dextrine.

7. Starch-paste yielded 52.7 per cent. sugar with diastase; not 87.9.

8. When the maximum yield is obtained, the sirup will not crystallize.

9. Starch cannot be converted into dextrine by diastase without forming sugar.

10. Diastase will act below 10.5°, or zero C.

11. Found 0.31 per cent. gypsum in sirup, 0.50 in glucose sugar.

Conversion of starch into sugar.

T. Musculus, (1862,) C. R., liv, p. 194; Dingl. J., clxiv, p. 150, (reply to Payen, in C. R., liii, p. 1217:) Under the influence of sulphuric acid, starch splits up into dextrine and sugar, absorbing water, just as fats take up water and split into glycerine and fatty acids. All glycosides do the same.

Action of ozone on glucose.

Gorup-Besanez, (1863,) Ann. Ch. Pharm., cxxv, p. 211: A solution of grape-sugar is not perceptibly changed by ozone until potash or soda, or even carbonate of soda, is added. When the action is ended, nothing remains but carbonic acid and formic acid.

Cane-sugar is oxidized far more slowly in alkaline solution, but yields the same products.

Action of nitric acid on levulo-glucose.

Hornemann, (1863,) J. Pr. Ch., lxxxix, p. 301: The pure levulo-glucose was made from inuline by long boiling in dilute nitric acid. This sugar was purified, and polarized strongly to the left.

After acting on it with nitric acid, specific gravity 1.40, it was entirely converted into racemic acid, (traubensäure,) which is inactive.

Action of diastase on starch.

A. Payen, (1865,) Ann. Chim. Phys., (1865,) p. 286; Dingl. J., clxxviii, p. 69: 1. Author has proved that diastase acts on dextrine, and is able to partially convert it into grape-sugar, (krümel.)

2. Diastase acting on starch can produce dextrine and grape-sugar in varying proportions, within the limits of 17 to 50 per cent. or more of sugar in the total product.

3. In making alcohol from grain, all of the starch excepting a few per cent. is gradually converted into sugar and alcohol.

EXPERIMENTS DESCRIBED IN DETAIL.

Action of water and neutral salt solutions on cane-sugar.

W. L. Classen, (1868,) J. Pr. Ch., ciii, p. 449: 1. Cane-sugar is gradually changed into glucose by pure water at ordinary temperatures without perceptible mould.

2. Some salts, like gypsum, potassium nitrate, &c., prevent this inversion; sulphate magnesia retards.

3. If left in contact with these salts for several days, then heated to 70° R. a few hours, rapid inversion occurs.

4. If the heating to 70° is done as soon as they are mixed, this inversion does not take place, except with gypsum.

5. Experiments can only last a few days, as it begins to mould.

His results contradict those of Béchamp regarding the action of pure water.

Maltine.

Dubrunfaut, (1868,) Les Mondes, xvi, p. 317; Dingl. J., clxxxvii, p. 491: Author applies this name to the active substance precipitated from malt-extract by tannin.

It is more active than diastase.

Malt contains 1 per cent. of this substance.

It is nitrogenous, like albuminoids, rotates light to the left, and is injured by heat and chemicals.

It is precipitated by 87 to 90 per cent. alcohol.

It is best prepared by extracting the malt cold, or at 30° C., with 4 or 5 parts of water; repeat, then add sumach, tanning-liquid, or other astringent.

Press in linen bags.

Why dilute sugar solutions ferment better than concentrated ones.

J. Wiesner, (1869,) J. Pr. Ch., cvi, p. 252: The rapid withdrawal of water from yeast-cells kills all except the younger, undeveloped cells. The effect of very concentrated solutions is to withdraw water from the cells and injure them.

The activity of the yeast depends on the inhibition of water by the protoplasm of the cell, and is in inverse proportion to the concentration of the sugar solution.

Proportions of levulose and dextrose in inverted sugars.

Manmené, (1869,) C. R., lxix, p. 1008; J. Pr. Ch., cviii, p. 315: Author found 12.14 per cent. dextrose, 87.86 per cent. levulose—total, 100.

The two were separated by combining the dextrose with sodium chloride, and evaporating until it crystallizes. Can also be separated by spreading the invert sugar, that has been dried at 100° C., on a plate of gypsum.

Author does not think this dextrose identical with that from urine.

Estimation of glucose, &c.

C. H. Gill, (1871,) Berl. Ber., iv, p. 283: Basic acetate of lead, when used to decolorize the liquid, has a perceptible effect on the rotatory power of the levulose, but not of dextrose.

Production of lactic acid from sugar without fermentation.

Hoppe-Seyler, (1871,) Berl. Ber., iv, p. 346: One pound of grape-sugar and ½ litre caustic soda, specific gravity 1.34, diluted with ½ litre water, heated in a large retort to 96°. Violent reaction set in, and temperature rose to 116°, without evolution of gas. The product contained lactic acid.

Conversion of glucose into dextrine.

Musculus, (1872,) Berl. Ber., v, p. 648: If grape-sugar is dissolved in cooled concentrated sulphuric acid, then alcohol added and left in a cool place, a white substance slowly separates, which exhibits the properties of dextrine, but has double the rotatory power of grape-sugar.

Action of saliva on starch.

H. A. Smith, (1873,) Sugar-Cane, v, p. 448: Author's experiments prove that the saliva of an infant four or five months old has no action whatever on insufficiently-cooked arrow-root, but healthy adult secretion has considerable transforming power, but the sugar is changed into lactic acid.

Healthy adult saliva entirely transforms well-boiled starch in the shortest space of time, while infant saliva causes no change for ten minutes.

Infants can only transform 12 per cent. of starchy food in two hours, and even this is changed into injurious lactic acid.

Maltose.

E. Schulze, (1874,) Berl. Ber., vii, p. 1048: The author's results resemble those of O'Sullivan. The diastase was precipitated from an aqueous extract of malt by alcohol, and mixed with starch-paste at 60°. The saccharine liquid was evaporated to small volume and alcohol added. The precipitate resembles dextrine. The solution was decanted, evaporated to a sirup, and boiled with strong alcohol. When cold, the clear solution was poured off and allowed to evaporate over sulphuric acid. It separated as a sirup, but afterwards turned to a mass of crystals.

A substance isomeric with saccharose.

Gautier, (1874,) Bull. Soc. Ch., (2,) xxii, p. 145; Berl. Ber., vii, p. 1549: A new substance, incapable of fermentation, ($C_{11}H_{22}O_{11}$,) made by the action of gaseous hydrochloric acid upon a cooled alcohol solution of grape-sugar. It is a white substance, resembling dextrine, of bitter taste, soluble in water and alcohol, dextro-rotatory, and reduces copper solutions.

Heated with water to 160° C. forms a sugar ($C_6H_{12}O_6$) that will not ferment, but reduces Fehling's solution.

Conversion of glucose into lactic acid.

Maly, (1874,) Berl. Ber., vii, p. 1567: When a dilute solution of cane, grape, or milk sugar or dextrine is kept at 20° to 40° C., and chopped mucous membrane of swine-stomach added, lactic acid is formed, and by neutralizing it from time to time, taking care never to make it alkaline, acid will continue to form as long as any sugar remains. It was identical with lactic acid from fermentation, but contained some sarco or para lactic acid. The proportions varied. It is attributed to an organized ferment in the dead tissue. Living stomachs, he says, cannot convert carbo-hydrates into lactic acid.

Conversion of sugar into lactic acid.

Gay-Lussac, (1874,) C. R.; Dingl. J., lxxiv, p. 80: Author refers to Frémy's preparation of lactic acid by means of the membrane of a calf's stomach, and says it seems to be a purely organic action. Lactic acid is produced in large quantity when sugar is in contact with a large quantity of nitrogenous organic matter at a temperature of 30° or 40° C. Lactic acid is formed often when a vegetable substance is in contact with an animal one.

Invert sugar.

Maumené, (1875,) Berl. Ber., viii, p. 698: Author thinks that invert sugar is a mixture of glucose with a levulo-rotatory sugar, which he calls "chylariose," and a neutral or inactive sugar. The relative proportions vary with the conditions of inversion and other treatment.

Unfermentable body in grape-sugar.

Neubauer, (1875,) Berl. Ber., viii, p. 1285: An average of thirteen analyses of commercial grape-sugars showed 18 to 20 per cent. of a substance that does not ferment, and rotates more strongly to the right than pure grape-sugar. It is not dextrine, but an unknown body between sugar and dextrine.

After fermenting a 10 per cent. solution of grape-sugar with fresh beer-yeast, filtering, and evaporating, a brown sirup remains, having a repulsive taste.

Action of saliva on starches.

Leuberg and Georgiewsky, (1876,) Berl. Ber., ix, p. 76: Other circumstances being the same, it takes less time to convert potato-starch into sugar than corn-meal, rice, or wheat-starch. Soluble starch is like potato-starch.

Inactive glucose.

Müntz, (1876,) Berl. Ber., ix, p. 351: Author found in sugar-cane that had been kept a long time an uncrystallizable glucose, that was inactive toward light. It ferments slowly. Also found mannite.

Dextrine in commercial starch-sirups.

Fr. Anthon, (1876,) Dingl. J., ccxix, p. 437: A sample of Bohemian sirup consisted of grape-sugar, 48.3; levulose sugar, 6.2; dextrine, 25.5; water, 20.

A French sirup consisted of grape-sugar, 30.1; levulose sugar, 5; dextrine, 48; water, 16.9.

A German sirup contained no dextrine, and 50 per cent. sugar.

Action of diastase and dilute sulphuric acid on starch.

Musculus and Gruber, (1879,) C. R., lxxxix, p. 1459; Berl. Ber., xii, p. 287: Substances formed are as follows:

Soluble starch; red, with I; rotat. $X = 218°$; red $= +6$.

Erythrodextrine; red, with I.

Achrodextrine, X; colorless, with I; rotat. X = 210°; red = 12.
Achrodextrine, B; colorless, with I; rotat. X = 190°; red = 12.
Achrodextrine, V; colorless, with I; rotat. X = 150°; red = 28.
Maltose, $C_{12}H_{22}O_{11}+H_2O$; rotat. X = 150°; red = 66.
Glycose, $C_6H_{12}O_6+H_2O$; rotat. X = 56°; red = 100.

Nature of the inactive glucoses in crude cane-sugar and molasses.

Gayon, (1878,) C. R., lxxxvii, p. 407; Berl. Ber., xii, p. 371: If pure mucor circinelloides is put in a liquid containing cane-sugar and a mixture of glucose and levulose in such proportions as to neutralize each other, so that the rotation is due to the cane-sugar, the rotatory power will decrease gradually (inversion) to a certain point, and then increase to the original value. In the fermentation of invert sugar the glucose is destroyed before the levulose. Gayon added this mucor to cane-sugar containing inactive glucose, and observed the same effect, showing that the inactive glucose has split into dextro and levulo glucose.

Causes of the inversion of cane-sugar and decomposition of glucose.

Durin, (1878,) C. R., lxxxvii, p. 754; Berl. Ber., xii, p. 371: There are three factors that effect the partial change of cane-sugar in glucose, viz., temperature, quality of the water and of the air.

If solutions of pure sugar and of sugar with 2, 3, 8, to 60 per cent. glucose are exposed for 30 or 40 hours to a temperature of 70° or 75°, while the alkalinity is maintained by the addition of a thousandth part of potassic hydrate, none of the sugar is converted into glucose. If the solution is kept at this temperature for 75 to 114 hours, the alkalinity disappears, and inversion begins. The optical activity of the glucose solutions is decreased, and the alcoholic fermentation is slower and less perfect.

Conversion of starch into sugar by diastase and carbonic oxide.

Baswitz, (1879,) Berl. Ber., xii, p. 1827: Some kinds of starch cannot be converted into sugar by diastase without the aid of carbonic acid, but other kinds can. Probably the latter are less pure than the former, the impurity supplying the place of the carbonic acid. Pressure has no effect. Best temperature is between 45° and 55°, (near 50°.) Above 60°, very little sugar is formed. At low temperature the sugar forms more slowly, but finally reaches the same quantity. More sugar is formed when more concentrated, but not a larger percentage referred to the quantity of starch.

Malto-dextrine.

Herzfeld, (1879,) Berl. Ber., xii, p. 2120: Author found that when diastase acts on starch, the best results are obtained below 65° C. Above that point there is, in addition to maltose, another substance formed, which dissolves in weak alcohol, but is not crystallizable. Rotatory power, $X = 173.4$ to 169.9. He calls it malto-dextrine. He made the acetyl compound.

Sugar from starch.

Allihn, (1880,) J. Pr. Ch., xxii, p. 46; Berl. Ber., xiii, p. 1761: The conversion is more rapid and more complete. The stronger the acid the longer it acts, and the higher the temperature. Up to 40 or 50 per cent. the conversion is proportional to the time, but afterwards slower. Maximum yield, 94.5 per cent.

APPENDIX E.

BIBLIOGRAPHY OF STARCH-SUGAR; PREPARED BY E. J. HALLOCK, PH. D.

List of journals consulted.

Journals.	Volumes.	Dates.
Annalen Chemie und Pharm	1 to 219	1832 to November, 1883.
Annales Chim. Phys	1 to (5) 27	1789 to October, 1883.
Annales d'Hygiène Pub	1 to 56	1854 to 1881.
American Chemist	1 to 6	1870 to 1876.
American Journal Med. Sciences		Several years.
Berichte der Deutsch. Chem. Ges	1 to 16	1868 to date.
Bulletin Soc. d'Encouragem	1 to 81	1802 to 1882.
Bulletin Soc. Chim., Paris	1 to 33	1864 to 1880.
Comptes Rendus	1 to 95	1835 to 1882.
Chemisches Centralblatt	1 to (3) 12	1835 to 1881.
Chemical Gazette	1 to 14	1842 to 1856.
Chemical News	1 to 47	1859 to June, 1883.
Die Chemischen Industrien	1 to 4	1878 to 1881.
Dingl. Polytech. Journal	1 to 249	1820 to November 21, 1883.
Du Bois Reymond's Archiv		1878 to 1883.
Gren & Gilbert's Annalen	Complete	
Jahresbericht der Chemie		1847 to 1881.
Jahresbericht der Reinen Chemie	1 to 9	1872 to date.
Jahresbericht der Zuckerfabrik	1 to 20	1862 to 1880.
Index Medicus	1 to 3	1878 to 1879.
Journal für Prak. Chemie	1 to 132	1834 to 1883.
Journal für Tech. Chemie	1 to 18	1828 to 1833.
Journal de Pharmacie et Chim	1 to (5) 8	1815 to 1880.
Mémoires de l'Acad. Méd	19 to 32	1855 to 1879.
New York Med. Journal		1865 to 1883.
Polytechnisches Centralblatt	1 to 40	1835 to 1874.
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1812	Döbereiner	Access of air necessary for conversion of starch into sugar.	Schweigg., v, 281.
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1812	Lampadius	Preparation of starch-sugar	Schweigg., vii, 253. Bull. Soc. d'Enc., xi, 213.
1812	Parmentier	Historical and chronological notice of sugars, (book notice.)	A. C. P., lxxxii, 332.
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1819	Mialhe	Theory of diabetes	A. C. P., (2,) xii, 120.
1821	Dubrunfaut	Rotatory power of sugars	A. C. P., (2,) xvii, 99.
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1841	Trommer	Action of grape-sugar on copper	A. C. P., xxxix, 360.
1841	Vogel	Digestion of starch	Valentin's Rep., (1841,) 293. Pharm. Centr., (1842,) 48.
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1847	Dubrunfaut	Analytical property of vinous and lactic fermentation; its use in recognizing the sugars.	A. C. P., (3,) xxi, 169. C. R., xxv, 307. Dingl. J., cvii, 351. J. Pr. Ch., xlii, 418. Pharm. Centr., (1847,) 889 (1848,) 10. J. B., (1848,) 792.
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1850	Maumené	Morino and stannic chloride test for sugar.	C. R., xxx, 314, 447. Instit., (1850,) 92, 122. Dingl. J., cxvi, 59. J. Pharm., (3,) xvii, 368. Pharm. Centr., (1850,) 349.
1850	Mulder	On the Trommer-Barreswil, Schwartz, and Fehling tests.	Scheik. Verh. en Onderz., v, 385. J. B., (1850,) 614.
1850	Soubeiran	Detection of starch-sirup in commercial sugars optically.	J. Pharm., (3,) xviii, 328. Dingl. J., cxix, 142. Pol. Centr., (1851,) 438, 570. J. B., (1850,) 613.
1850	Wilhelmy	The law that governs the action of acids on cane-sugar.	Pogg., lxxxi, 413.
1851	Casaseca	Silver salts reduced by sugar	C. R., xxxii, 686; xxxiv, 111.
1851	Clerget	Remarks on Dubrunfaut's saccharimeter. (See below.)	C. R., xxxii, 305; xxxiii, 32. Dingl. J., cxxx, 303.
1851	Donaldson	Reagent for sugar in blood	J. Chim. Méd., (1851,) 641. Dingl. J., cxxii, 399.
1851	Dubrunfaut	Saccharimetry	C. R., xxxii, 249. Pharm. Centr., (1851,) 278. Dingl. J., cxxi, 299. Pol. Centr., (1851,) 738.
1851	Lüdersdorf	Maize for sugar-making	Ann. Landwirthschaft. Zeitsch. für Landwirth., (1851.) Pol. Centr., (1851,) 1447.
1851	Pasteur	Combination of grape-sugar and sodium chloride; relation of crystallized form to chemical composition and polarization.	A. C. P., (3,) xxxi, 92. J. Pr. Ch., lii, 413. A. C. P., lxxx, 150. J. B., (1850,) 534.
1851	Reynoso	Sugar appears in urine when respiration is checked, and in epilepsy.	C. R., xxxiv, 410, 418; xxxvi, 20. J. Pharm., (3,) xx, 351. Pharm. Centr., (1851,) 911, (1852,) 96, (1853,) 101.
1851	Rübsamen	Adulteration of brown sugar with 58 per cent. of starch; only 30 per cent. cane-sugar.	Jahrb. Prak. Pharm., xxii, 197. Pol. Centr., (1852,) 56.
1851	Soubeiran	Detecting starch-sugar in cane-sirups	J. Pharm., (3,) xx, 401. Dingl. J., cxxv, 292; (cxix, 142.) J. B., (1851,) 647.
1852	Barreswil	Sugar in urine	J. Pharm., (3,) xxi, 27.
1852	Baumert	Sugar in blood	J. Pr. Ch., liv, 357. Pharm. Centr., (1852,) 192.
1852	L'hermite	Conversion of mannite into sugar by yeast.	J. B., (1851,) 591. C. R., xxxiv, 114. Pharm. Centr., (1852,) 160.
1852	Pohl	Cold produced by dissolving grape-sugar.	Wien. Acad. Ber., vi, 598. J. Pr. Ch., lvi, 218.
1853	Faisst	Quantity of sugar in fruits and berries	Würtemberg. Gew., (1853,) 6, 7. Dingl. J., cxxvii, 316.
1853	Fouschard	Granular starch-sugar	Bull. Soc. d'Enc., lii, 145. Pol. Centr., (1853,) 1407.
1853	Petzholdt	Solubility of quartz in sugar solution	J. Pr. Chem., lx, 368.
1853	Rigaud	Action of sugar on copper solution	A. C. P., xc, 297.
1854		Bitter taste of starch-sugar caused by excess of lime; add tartaric acid or acetic.	Monat. Nachr., (1854,) 1. Pol. Centr., (1854,) 252.
1854	Arnould	Dextrine, sugar, and alcohol from wood.	C. R., xxxix, 807. Dingl. J., cxxxiv, 219.
1854	Lawes and Gilbert	Equivalency of starch and sugar in food.	Brit. Assoc., xxiv, 70. Chem. Gaz., xii, 396.
1854	Horsley	Alkaline-chromate test for sugar	Chem. Gaz., (1854,) 314. J. Pr. Ch., lxiii, 320.
1854	Lahens	Glucose in opium, lactucarium, and vegetables generally.	J. Pharm., (3,) xxvi, 263.
1854	Maumené	Quantitative estimation of sugar with chloride of tin.	Monit. Ind., (1854,) 1888. Dingl. J., cxxxiii, 376. C. R., xxxix, 422. Pharm. Centr., (1854,) 735.

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1854	Maumené	Changes pure water causes in sugars and on analysis of sirups.	C. R., xxxix, 914. Dingl. J., cxxxv, 59. Pol. Centr., (1855,) 624.
1854	Rigaud	Grape and milk sugars reduce unequal quantities of copper.	A. C. P., xc, 297. Pharm. Centr., (1854,) 768. J. B., (1854,) 746.
1854	Schunck	Action of madder ferment on sugar	Memoir. Lit. and Phil. Soc., Manchester, xii,109. Phil. Mag., (4,) viii, 161. J. Pr. Ch., lxiii, 222. Pharm. Centr., (1854,) 813. J. B., (1854,) 620.
1854	Staedeler	Grape-sugar and sodium chloride	Mitth. Nat. Ges., Zurich, (1854,) 473. Chem. Gaz., xiii, 44, 67. Pharm. Centr., 936, 954. J. B., (1854,) 746.
1855	Baudrimont	Quantity of sugar in urine varies at different hours.	C. R., xli, 176. J. Pr. Ch., xlvii, 188. Pharm. Centr., (1855,) 704.
1855	Béchamp	Action of water on cane-sugar in presence of CaCl or ZnCl.	C. R., xl, 437. Instit., (1855,) 90. Pol. Centr., (1855,) 624. J. Pharm., (3,) xxvii, 274. J. B., (1855,) 670.
1855	Bocken	Changes that sugar undergoes during nutrition.	J. Pharm., (3,) xxvii, 298.
1855	Berthelot	Neutral compound of acid with saccharine bodies.	Gaz. Méd., Paris, (1857,) 1. N. Rep. Pharm., vi, 67. C. R., xli, 452. Instit., (1855,) 322. J. Pr. Ch., lxvii, 235. J. B., (1855,) 675.
1855	Blondlot	Digestion of amylaceous substances	A. C. P., (3,) xliii, 228.
1855	Boedeker	Fehling's solution	Henle's Zeit. Rat. Med., vi, 2. Schmidt's Jahrb. Ges. Med., lxxxviii, 156. J. B., (1855,) 819.
1855	Erdmann	Rotatory power of fresh solutions of sugar.	Dissertation. J. B., (1855,) 671.
1855	Lahens	Aldehyde and glucose, same reactions	J. Pharm., (3,) xxvii, 37. J. Pr. Ch., lxv, 313. J. B., (1855,) 820.
1855	Leplay	Manufacture of sugar from grain by sulphuric acid.	Genie Ind., (1855,) 297. Dingl. J., cxxxviii, 424.
1855	Melsens	Method of using various vegetable substances (cellulose) to make fruit-sugar.	Genie Ind., (1855,) 106. Dingl. J., cxxxviii, 426.
1855	Reynoso	Action of glucose on copper salts	C. R., xli, 278. J. Pr. Ch., lxvi, 465. Pharm. Centr., (1855,) 720. Chem. Gaz., xiii, 385.
1855	Schunck	Sugar by action of acids on indican	J. Pr. Ch., lxvi, 330. Phil. Mag., x, 73.
1856	Béchamp	Probable existence of two kinds of amorphous grape-sugar.	C. R., xlii, 896, 640. J. Pr. Ch., lxix, 433. J. B., (1856,) 640.
1856	Berthelot	Fermentation of sugars, &c., by cheese and animal membranes.	C. R., xliii, 238. J. Pr. Ch., lxix, 455.
1856	Berthelot	Products of fermentation	Instit., (1856,) 267. Ch. Centr., (1856,) 749.
1856	Biot	On the use of the term "glucose"	C. R., xlii, 351. J. Pr. Ch., lxviii, 429. Pharm. Centr., (1856,) 255. Instit., (1856,) 92. J. B., (1856,) 638.
1856	Dubrunfaut	Birotatory power of "krümel" sugar (glucose mamelone) and milk-sugar.	C. R., xlii, 228, 739, 901. Instit., (1856,) 161. J. Pr. Ch., xlii, 425; lxviii, 422; lxix, 438. Pharm. Centr., (1856,) 233. J. B., (1856,) 640.
1856	Gall	Improved method of neutralizing with aid of acetic acid.	Gall's Prakt. Mitth., i, 149. Pharm. Centr., (1856,) 80. Pol. Centr., (1856,) 62. Dingl. J., cxxxviii, 239. Wag., (1855,) 199.
1856	Gall	An intentionally adulterated glucose with bad odor.	Pol. Notizbl., (1856,) 367. Dingl. J., cxxxix, 468.

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1856	Siegle	Preparation of pure grape-sugar from honey.	J. Pr. Ch., lxix, 148. Ch. Centr., (1856,) 960. Pol. Centr., (1856,) 206. J. Pharm., (3,) xxxi, 240. J. B., 1856, 638. Wag., (1856,) 225.
1856	Völcker	St. John's bread contains 41.2 per cent. grape-sugar.	Dingl. J., cxlvi, 390.
1856	Von Kobell	Crystalline form of the compound of grape-sugar and sodium chloride.	J. Pr. Ch., xxviii, 489 lxix, 218.
1856	Wicke and Listing	Quantitative determination of sugar in diabetic urine.	J. Pr. Ch., lxvii, 134. A. C. P., xcvi, 87, 93.
1856		Extent of the starch-sugar industry in Germany.	Pol. Centr., (1856,) No. 14.
1857	Anthon	Making crystallized glucose	Dingl. J., cxlvii, 76. Ch. Centr., (1858,) 205. Pol. Notizbl., (1858,) 120. J. B., (1858,) 658. Wag., (1858,) 328.
1857	Berthelot	Alcoholic fermentation	J. B. für Pharm., ix, 250. C. R., xliv, 702; lx, 29. J. Pr. Ch., lxxi, 321. A. C. P., (3,) l, 322.
1857	Berthelot	A peculiar sugar from mannite and glycerine.	C. R., xliv, 1002. J. Pr. Ch., lxxi, 507. A. C. P., (3,) l, 369.
1857	Berthelot	Compounds of saccharine substances with tartaric acid.	C. R., xlv, 268. Instit., (1857,) 283. J. Pr. Ch., lxxiii, 157. A. C. P., (3,) liv, 74. J. Pharm., (3,) xxxiii, 95. Ch. Gaz., (1857,) 441. J. B., (1857,) 506.
1857	Bernard, Sanson, and Figuier.	Formation of sugar in the liver	C. R., xliv, 578, 1159, 1213, 1321, 1323, 1325.
1857	Böttger	New reagent for grape and cane sugar, (bismuth.)	Pol. Notizbl., xii, 97. Dingl. J., cxliv, 368. J. Pr. Ch., lxx, 432. N. Rep. Pharm., vi, 132. Ch. Centr., ii, 704. J. B. d. Phys. Verein. Frankf., 1855–'56.
1857	Böttger	Sugar test in albuminous urine	Dingl. J., cxlviii, 317.
1857	Carton and Parsons	Conversion of cane into fruit sugar for making alcoholic liquors by means of acid.	Jour. of Arts., (1857,) 212. Dingl. J., cxlvi, 317.
1857	Hoppe	Influence of cane-sugar on digestion and nutrition.	Virchow's Archiv., x, 144. Ch. Centr., (1857,) 33.
1857	Pelouze	Influence of free alkali on fermentation of starch and urine sugars.	Cosmos, x, 390. Dingl. J., cxliv, 310.
1857	Schiff	Amount of copper reduced by grape and milk sugars.	A. C. P., civ, 330. J. Pr. Ch., lxxiii, 314.
1858	Balling	Grape-sugar	Dingl. J., cxlvii, 78. Pol. Centr., (1858,) 349.
1858	Béchamp	Conversion of cane-sugar into fruit-sugar by water and different solutions.	C. R., xlvi, 44. Pol. Centr., (1858,) 595. Dingl. J., cxlix, 207. A. C. P., (3,) liv, 28. Pol. Centr., (1858,) 595.
1858	Berthelot	Fermentation of cane-sugar and glucose.	N. Rep. Pharm., vii, 187.
1858	Berthelot	Conversion of certain constituents of shell-fish into sugar.	C. R., xlvii, 227. Ch. Centr., (1858,) 675.
1858	Berthelot	Melizitose in manna	C. R., xlvii, 224. J. Pr. Ch., lxxvi, 188. A. C. P., (3,) lv, 269.
1858	Berthelot	Trehalose-glucose by action of acid on trehalose.	C. R., xlvi, 1276. J. Pr. Ch., lxxiv, 494.
1858	Brücke	Testing for sugar in urine	Zeitsch. für Aerzte. Wien., (1858,) 589. Ch. Centr., (1858,) 705. J. Pr. Ch., lxxiv, 115. Wien. Akad. Ber., xxxix, 10. Ch. Centr., (1860,) 231. J. Pharm., (3,) xxxiv, 237.

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1858	Hoffmann, T. A	Making grape-sugar under pressure	Sc. Amer., Aug. 7, 1858. Dingl. J., cxlix, 320. Pol. Centr., (1858,) 1392. J. B., (1858,) 658. Wag., (1858,) 328.
1858	Löwenthal	Delicate test for grape-sugar, ferric chloride, &c.	J. Pr. Ch., lxxiii, 71. Ch. Centr., (1858,) 320. Dingl. J., cxlviii, 456. Pol. Centr., (1858,) 831. J. Pharm., (3,) xxxiii, 398. J. B., (1858,) 633. Wag., (1858,) 328.
1858	Marx	Percentage of sugar in grape and fruit juices of 1857.	Würt. Land- und Forst-wirth. Z. Dingl. J., cl., 143. Ch. Centr., (1858,) 918. J. B., (1858,) 658. Wag., (1858,) 330.
1858	Poissuille and Lefort	Glucose in animal organs	C. R., xlvi, 565, 677. J. Pr. Ch., lxxiii, 467.
1858	Werther	Quantitative examination of sugar	J. Pr. Ch., lxxiv, 371. J. B., (1858,) 635.
1859	Anthon	Chemical and technical knowledge of grape-sugar, (potato-sugar.)	Dingl. J., cli, 213. Pol. Notizbl., (1859,) 92. Ch. Centr., (1859,) 289. Pol. Centr., (1859,) 597. J. Pharm., (3,) xxxv, 298. J. B. Pharm., xi, 368. J. B., (1859,) 736. Wag. J. B., (1859,) 359.
1859	Anthon	Influence of argols and tartaric acid on fermentation of grape-juice and pure sugar solution.	Dingl. J., cliv, 223.
1859	Berthelot and De Luca	Sugar from glycogen of the liver	C. R., xlix, 213. Instit., (1859,) 246. J. Pr. Ch., lxxxi, 188. J. Pharm., (3,) xxxvi, 290. A. C. P., (3,) lviii, 408. Ch. Centr., (1859,) 880. J. B., (1859,) 627.
1859	Gentele	Estimating cane and grape sugar and dextrine in one solution.	Dingl. J., clii, 68, 139. Pol. Centr., (1859,) 1156, 1679.
1859	Hoffmann, T. A	Conversion of starch into sugar at 107° to 149° C. under pressure.	Archiv. Pharm., cxlviii, 110. Ch. Centr., (1859,) 509.
1859	Löwenthal	Note on Fehling's solution	J. Pr. Ch., lxxvii, 336. Pol. Centr., (1859,) 1618.
1859	Mège-Mouriès	Action of bran of wheat on the fermentation of starch.	Bull. Soc. d'Enc., lviii, 580.
1859	Michaelis	Other sugars in beets, called left or null trehalose.	J. Pr. Ch., lxxiv, 397.
1859	Mulder	Detection of grape and fruit sugar by means of indigo.	Scheik. Verh. en Onderz., ii, 82. Archiv. Pharm., cxlv, 268. Dingl. J., cliv, 158. Pol. Centr., (1860,) 559. Pol. Notizbl., (1859,) 316. Ch. Centr., (1859,) 974. J. B., (1858,) 633. Wag., (1859,) 368.
1859	Pary	On the power which the liver has of producing sugar.	J. Pr. Ch., lxxvii, 354. Phil. Mag., (4,) xvii, 142.
1859	Pelouze	Conversion of woody fibre into grape-sugar by acids.	C. R., xlviii, 327. Dingl. J., cli, 394.
1859	Stepf	Sugar in maize is dextro-rotatory, and reduces Fehling's solution.	J. Pr. Ch., lxxvi, 92.
1860	Anthon	Solubility of pure grape-sugar in alcohol.	Dingl. J., clv, 386. Pol. Centr., (1860,) 1278. Ch. Centr., (1860,) 292. J. Pharm., (3,) xxxvii, 396. J. B., (1860,) 507. Wag., (1860,) 367.

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1860	Berthelot	Glucosic fermentation of cane-sugar	C. R., l, 980. Instit., (1860,) 203. J. Pharm., (3,) xxxviii, 33. Rep. Chim. Pure, ii, 272. Zeit. Ch. Pharm., (1860,) 458. Ch. Centr., (1860,) 606. J. B., (1860,) 519.
1860	Berthelot and De Luca	Sugar from hepatic glycogen	A. C. P., (3,) lviii, 448.
1860	Bnignet	The sugar in acid fruits	C. R., li, 894. J. Pr. Ch., lxxxvi, 493. A. C. P., (3,) lxi, 233. J. Pharm., (3,) xxxix, 81. Rep. Chim. Pure, iii, 76. Ch. News, iii, 227. J. B., (1860,) 537.
1860	Corvisart and N. de St. Victor.	Action of sunlight on cane-sugar	C. R., xlix, 368; li, 317. A. C. P., cxiii, 112. Dingl. J., clvi, 39. Wag. J. B., (1860,) 369.
1860	Gélis	Researches on the sugars	C. R., li, 331; xlviii, 1062. J. Pharm., (3,) xxxviii, 263. Rep. Chim. Pure, ii, 479. Zeit. Ch. Pharm., (1861,) 57. J. B., (1860,) 510.
1860	Musculus	Conversion of starch into glucose and dextrine.	C. R., l, 785; liv, 194. A. C. P., (3,) lx, 203. Instit., (1860,) 147. J. Pr. Ch., lxxxv, 243. J. Pharm., (3,) xxxviii, 419. Ch. News, ii, 299. Dingl. J., clviii, 424. Zeit. Ch. Pharm., (1860,) 379. Ch. Centr., (1860,) 602. Pol. Centr., (1861,) 352. J. B., (1860,) 502.
1860	Pohl	Reduction of temperature in solutions of grape-sugar.	Wien. Akad. Ber., vi, 595. J. Pr. Ch., lxxxii, 154. A. C. P., civ, 330; cxii, 368.
1860	Schiff	Action of grape-sugar on alkaline tartrate of copper.	J. B., (1859,) 697.
1860	Schoonbrodt	Transformation of sugar and starch into albuminoids.	C. R., l, 856. J. Pharm., (3,) xxxvii, 430. J. B., (1860,) 566.
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1861	Boedeker and Fischer	Conversion of cartilage into sugar	A. C. P., cxvii, 111. J. Pr. Ch., lxxxiv, 18. Ch. Centr., (1861,) 204. A. C. P., (3,) lxii, 236. J. Pharm., (3,) xxxix, 465. Rep. Chim. Pure, iii, 287. J. B., (1861,) 809.
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1861	Jones, B.	Sugar in urine	Ch. News, iii, 29. Zeit. Ch. Pharm., (1861,) 102. Z. Anal. C., i, 128.
1861	Luca	Sugar from silk-worm skin	C. R., liii, 102; lvii, 437. Instit., (1861,) 243. Rep. Chim. Pure, iii, 405. J. Pharm., (3,) xli, 357. J. Pr. Ch., lxxxviii, 500; xci, 319. J. B., (1861,) 721.
1861	Mulder	Testing for grape-sugar with alkaline-indigo solution.	Scheik. Verh. en Onderz. Ch. Centr., (1864,) 176. Z. Anal. C., i, 96, 377. Ch. News, iii, 224.

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1861	Pohl	Preparation of caramel and assamar	Wien. Akad. Ber., xli, 623. J. Pr. Ch., lxxxii, 48.
1861	Schmidt	Detection of grape in cane sugar with lead acetate and ammonia.	A. C. P., cxiv, 102; cxix, 102. Dingl. J., clxi, 399. Z. Anal. C., i, 96. Chem. N. V., 98, 213. Pol. Notizbl., (1861,) 304. Wag. J. B., (1861,) 429.
1861	Schmidt	Grape-sugar from salicine and amygdaline.	A. C. P., xxix, 92.
1861	Zwenger and Kind	Glucose from solanine	A. C. P., cxviii, 149.
1861		Sugar in urine of the fox	Wien. Akad. Ber., lii, 523. Ch. News, iv, 247.
1862	Anthon	Sodium chloride and grape-sugar soluble in 0.66 water.	Dingl. J., clxvi, 69. J. B., (1862,) 472.
1862	Berthelot	Compound of glucose with stearic acid	A. C. P., (3,) lx, 93. J. B. Zuck. Fab., i, 204.
1862	Boedeker	Specific gravity of different sugars	J. B. Zuck. Fab., i, 203.
1862	Iodin	Isomeric transformation of cane-sugar under the influence of a specific ferment.	C. R., lv, 720; lviii, 434. Bull. Soc. Chim., (1863,) 93. Chem. Centr., (1863,) 72. J. B., (1862,) 472.
1862	Löwenthal and Leussen	Influence of time, temperature, nature, and strength of acid used.	J. Pr. Ch., lxxxv, 321.
1862	Musculus	Conversion of starch into dextrine and sugar.	C. R., liv, 194. Dingl. J., clxiv, 150. Z. C. P., (1862,) 169. Pol. Centr., (1862,) 680. Rep. Chim. Pure, iv, 148. Schweiz. Pol. Zeit., (1862.) 167. Bayer, Kunst., und Gew., (1862,) 438. J. B., (1861,) 719. Wag. J. B., (1862,) 404.
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1863	Anthon	A method for preparing starch-sugar of pure flavor, intensely sweet, hard, and crystalline.	Dingl. J., clxviii, 456. Pol. Notizbl., xviii, 154. J. Pharm., (3,) xliv, 173. Ch. News, viii, 42. Ch. Centr., (1864,) 144. Würt. Gewerbebl., (1863,) 299. Pol. Centr., (1863,) 1181. Neue Erfind., (1863,) 108. Sc. Amer., xi, 343. J. B., (1863,) 767. Wag. J. B., (1863,) 471.
1863	Böttger	Action of chloride of lime upon sugars and starch.	Dingl. J., clxix, 316.
1863	Brunner	Estimation of sugar with Fehling's solution.	Pol. Centr., (1863,) 561. Rep. Chim. Appl., (1863,) 364. Wag. J. B., (1863,) 364.
1863	Gorup-Besanez	Action of ozone on glucose	A. C. P., cxxv, 211. Ch. Centr., (1863,) 473. Bull. Soc. Chim., v, 420. J. B., (1863,) 141.
1863	Grouven	Formation of sugar in the potato-mash	Dingl. J., clxix, 238.
1863	Hornemann	Formation of tartaric and racemic acid by action of nitric acid on carbohydrates.	J. Pr. Ch., lxxxix, 283. C. C., (1864,) 150. J. B., (1863,) 380.

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1863	Pohl	Test for starch-sugar in wine	Behelfe zum Gallis. d. Wein., 65. Wag. J. B., (1863,) 472.
1863	Reichardt	Action of grape-sugar on copper solutions.	A. C. P., cxxvii, 297. J. Pharm., (3,) xliv, 453. Archiv. Pharm., (2,) cxvii, 29. C. C., (1864,) 45. Bull. Soc. Chim., (2,) vi, 197.
1863	Reischauer	Estimation of sugar and dextrine in beer.	N. Rep. für Pharm., xi, 50. Z. Anal. C., ii, 233. C. C., (1864,) 367. J. B., (1863,) 711.
1863	Roders	Honey made by bees when fed on glucose.	Archiv. Pharm., (2,) cxvi, 29. Dingl. J., clxix, 158. J. B. Zuck. Fab., iv, 189; iii, 225. Viertelj., Pr. Pharm., xiii, 214. Z. C. P., (1863,) 259. C. C., (1863,) 1008. J. B., (1863,) 1008.
1863	Scheibler	Action of light on solutions of invert sugar.	Dingl., clxix, 379. J. Pharm., (3,) xliv, 452. Bull. Soc. Chim., vi, 281. Pol. Centr., (1863,) 1518. Pol. Notizbl., (1863,) 294. J. B. Zuck. Fab., (1863,) 194. J. B., (1863,) 574. Wag. J. B., (1863,) 473.
1863	Schönbein	Catalytic activity of organic materials like gluten, emulsine, myrosine, yeast, and saliva.	J. Pr. Ch., lxxxix, 323.
1863	Vogel	Use of dialyser in estimating glucose in beer.	C. C., (1862,) 1244. Ch. News, vii, 179.
1864	Brunner and Vogel	Chloride of silver reduced by starch-sugar.	Dingl. J., clxxi, 363. J. Pr. Ch., lxxxvi, 326; xci, 254. C. C., (1864,) 880, 926. J. B., (1864,) 285.
1864	din	Influence of optically inactive substances on the rotatory power of sugar.	Bull. Soc. Chim., (2,) i, 432. C. R., lviii, 613. Instit., (1864,) 114. Dingl. J., clxxiii, 143. C. C., (1864,) 477. Pol. Centr., (1865), 77. J. B., (1864,) 573.
1864	Leuchs	Thin starch paste converted into sugar by raw potato-parings at 45° to 50° C.	J. Pr. Ch., xcii, 59. Dingl. J., clxxiii, 157. C. C., (1864,) 1088. Bull. Soc. Chim., (2,) ii, 393. J. B., (1864,) 571.
1864	Leuchs	Relative value of different sugars as food for yeast-cells.	J. Pr. Ch., xciii, 409, 399. C. C., (1865,) 389. Bull. Soc. Chim., (2,) iv, 155. J. B., (1864,) 579.
1864	Manbré	Manufacture of starch-sugar with acid at 135° to 160° C.	Mech. Mag., (Nov., 1864,) 377, 475. Dingl. J., clxxv, 309. C. C., (1865,) 720. J. Pharm., (4,) ii, 413. Pol. Centr., (1865,) 544. Sc. Amer., xii, 21. J. B., (1865,) 825. Wag. J. B., (1865,) 500.
1864	Millon	Changes in sugar by fermentation; NH formed.	C. R., lvii, 325; lix, 144. J. Pr. Ch., xciii, 9. J. B., (1864,) 579.
1864	Duclaux	Changes in sugar by fermentation; NH formed.	C. R., lviii, 1114.
1864	Payen	Illustration of apparatus employed in making sugar from starch.	Sc. Amer., xi, 403.

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1864	Spirgatis	Glucose from turpeth root	J. Pharm., (4,) i, 236. J. Pr. Ch., xcii, 102. Z. C. P., (1864,) 442. C. C., (1864,) 763. Viertelj. Pr. Pharm., xiv, 386. Bull. Soc. Chim., (2,) ii, 382. Instit., (1864,) 403. J. B., (1864,) 591.
1864	Stenhouse	Compound of dextro-glucose and sodium bromide.	J. Ch. Soc., (2,) i, 297. J. Pr. Ch., xcii, 350. A. C. P., cxxix, 286. C. C., (1864,) 64. Bull. Soc. Chim., (2,) vi, 60. J. B., (1863,) 574.
1865	Blondeau	Sugar a product of slow decomposition of gun-cotton.	C. R., lx, 128; lxi, 378. J. Pr. Ch., xciv, 64, 318. Instit., (1865,) 299. C. C., (1865,) 997. Dingl. J., clxxviii, 147. J. B., (1865,) 575.
1865	Boussingault	Formation of glucose by leaves	C. R., lx, 872; lxi, 664. Instit., (1865,) 322, 329, 354. Ch. News, xii, 293. Bull. Soc. Chim., (2,) iii, 444; v, 396. Z. C., (1865,) 535, 731. C. C., (1865,) 628, 983, 1153. J. B., (1865,) 615.
1865	Braun	Picric-acid test for glucose	Z. Anal. C., iv, 187. Z. C., (1865,) 744. Dingl. J., clxxx, 327. C. C., (1866,) 218. J. Pr. Ch., xcvi, 414. J. Pharm., (4,) iii, 474. Pol. Notizbl., (1865,) 27. J. B., (1865,) 526. Wag. J. B., (1866,) 399.
1865	Carius	Synthesis of phenose ($C_6H_{12}O_6$) an isomere of glucose.	A. C. P., cxxxiv, 71. C., xxxvi, 323. Z. C., (1866,) 67. A. C. P., (4,) viii, 193. C. C., (1866,) 84. Bull. Soc. Chim., (2,) vi, 61. Phil. Mag., (4,) xxxi, 453. Ch. News, xiii, 161. J. B., (1865,) 533.
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1865	Icery	Levulose in sugar-cane	A. C. P., (4,) v, 394, 404. J. B., (1865,) 818.
1865	Nickles	Bichloride of carbon for distinguishing grape from cane sugar.	C. R., lxi, 1053. Bull. Soc. Chim., (2,) vi, 90. Deut. Ind. Zeit., (1866,) 45. J. Pr. Ch., xcvii, 439. Dingl. J., clxxix, 315. Instit., (1865,) 396. Ch. News, xii, 299. Z. Anal. C. V., 412. J. Pharm., (4,) iii, 119. Z. C., (1866,) 96. C. C., (1866,) 527. J. B., (1865,) 601, Wag. J. B., (1865,) 501, (1866,) 400.

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1865	Schützenberger	Action of anhydrous acetic acid upon cellulose, starch, and sugar.	C. R., lxi, 485. J. B., (1865,) 594.
1865	Schützenberger	Some further experiments on the same.	A. C. P., (4,) xxi, 249. Bull. Soc. Chim., (2,) v, 290. Z. C., (1866,) 16. C. C., (1865,) 1036. J. Pr. Ch., xcvii, 250. J. Pharm., (4,) ii, 376.
1866	Anders	Technical estimation by polariscope and sources of error.	Zeit. Ver. D. Ing., x, 321. Dingl. J., cxxxii, 331. J. B., (1866,) 882.
1866	Assmuss	Caramel from glucose	Fab. Zuckerc., Berl'n, 1866. Deut. Ind. Zeit., (1866,) 222. Bull. Soc. d'Enc., lxvi, 534. Dingl. J., clxxxi, 334. Pol. Centr., (1866,) 893. Pol. Notizbl., (1866,) 210. Wag. J. B., (1866,) 401.
1866	Bergerson	Quantitative estimation of sugar in urine by fermentation.	N. Rep. Pharm., xv, 82. Z. Anal. C. V., 264. C. R., lxiii, 803.
1866	Kessler-Desvignes	New ideas concerning action of acids, such as HF, on sugar-juices.	Bull. Soc. Chim., (2,) vii, 530. Z. C., (1866,) 736. Dingl. J., clxxxiii, 303. J. B., (1866,) 880.
1866	Kleinschmidt	Estimation of different sugars	Dingl. J., cxxxi, 306. Pol. Centr., (1866,) 1332.
1866	Lawes	Estimation of sugar in barley	Ch. News, xiii, 161, 191.
1866	Payen	Dextrine and glucose from starch	A. C. P., (4,) vii, 393. Z. C., (1866,) 334.
1866	Stahlschmidt	Estimation of sugar by ferrocyanides	Z. Anal. C., vii, 494.
1867	Boussingault	Non-fermentable reducing substance in black cherries.	A. C. P., (4,) viii, 231. J. B., (1867,) 741.
1867	Hlasiwetz	Relation of different tannic acids to glucosides.	Wien. Akad. Ber., lv, (2te Ab.,) 575. J. Pr. Ch., cv, 360.
1867	Phillipp	Estimation of starch	Z. C., (N. S.,) iii, 400. Z. Anal. C., vi, 471. Bull. Soc. Chim., (2,) viii, 363.
1867	Sestini	Sugar in dried fruits	Bull. Soc. Chim., (2,) vii, 236. Wag. J. B., (1867,) 443.
1867	Sherlock	Caramel from starch-sugar	Ch. News, xv, 282. Dingl. J., clxxxv, 236. Pol. Centr., (1867,) 1215. Wag. J. B., (1867,) 441.
1867	Thompson	Caramel from glucose	Ch. News, xv, 242.
1868	Böttger	Starch-sugar for gilding on glass	Pol. Notizbl., (1868,) 129. J. Pr. Ch., ciii, 414. Dingl. J., clxxxviii, 288. Pol. Centr., (1868,) 984. C. C., (1868,) 1053. Bull. Soc. Chim., (2,) x, 164. Schweiz. Pol. Zeit., (1868,) 114. Fürther Gewerb., (1868,) 64. Hess. Gewerb., (1868,) 223. Deut. Ind. Zeit., (1868,) 194. J. B., (1868,) 944. Wag. J. B., (1868,) 194.
1868	Classen	Cane-sugar inverted by water and neutral solutions of salts.	J. Pr. Ch., ciii, 449. J. B., (1868,) 758. A. C. P., cxlvii, 114.

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1868	Commaille	Reduction of copper oxide to metal by invert sugar.	J. Pharm., (4,) viii, 18. Ch. News, xviii, 181. Z. C., (1868,) 719. J. B., (1868,) 269.
1868	Dobell	Action of pancreas on fats and starch...	Proc. Roy. Soc., xvi, 209. J. Pr. Ch., civ, 443. J. B., (1868,) 830.
1868	Dubrunfaut	Conversion of starch into sugar by malt, and on the preparation of a nitrogenous substance from malt more active than diastase, (maltine.)	C. R., lxvi, 274. Les Mondes, xvi, 317. C. C., (1868,) 1062. Dingl. J., clxxxvii, 491. Pol. Centr., (1868,) 759. Z. C., (1868,) 351. Bull. Soc. Chim., (2,) x, 54. J. B., (1868,) 799.
1868	Gräger	Conversion of cane into grape sugar by parasites of vine.	N. Jahrb. Pharm., xxix, 294. Pol. Centr., 1869. J. B., (1868,) 759.
1868	Gräger	A Fehling's solution that will keep well.	N. Jahrb. Pharm., xxix, 193. Z. Anal. C., vii, 490. J. B., (1868,) 894.
1868	Lea	Nitro-glucose	Am. J. Sci., (2,) xlv, 381. J. Pr. Ch., cv, 191. J. Pharm., (4,) viii, 461.
1868	Martin	Silvering glass with inverted sugar	A. C. P., (4,) xv, 94. Dingl. J., cxci, 43. J. B., (1868,) 943.
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1868	Scheibler	Effects of the glass cover in the optical estimation of sugar.	Berl. Ber., i, 268. Z. Anal. C., viii, 211. N. Jahrb. Pharm., xxix, 270. Z. Anal. C., vii, 491.
1868	Stahlschmidt	Ferrocyanides for estimating sugar in wine.	Berl. Ber., i, 141. Dingl. J., clxxxix, 330. Z. Anal. C., vii, 493. Z. C., (1868,) 720. J. B., (1868,) 895.
1868	Stenberg	Lichens for making grape-sugar and alcohol.	Oefvers. af K. V. A. Förh., (1868,) 17. J. Pr. Ch., civ, 441; cvi, 416.
1869	Baeyer	Action of phosphorous pentachloride on glucose.	Berl. Ber., ii, 54. Z. C., (1869,) 345. Bull. Soc. Chim., (2,) xii 292. J. B., (1869,) 742.
1869	Classen	Analysis of grapes	J. Pr. Ch., cvi, 9. Ch. News, xix, 204.
1869	Dubrunfaut	Inversion of cane-sugar is attended with contraction.	C. R., lxix, 1199.
1869	Dubrunfaut	Separating glucose and levulose by means of lime.	C. R., lxix, 1151, 1366. Berl. Ber., iii, 36. Cane-Sugar, ii, 131. J. B., (1869,) 743.

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1869	Dubrunfaut	Occurrence of glucose in beet-sugar, 0.2 to 1.2 per cent.	C. R., lxviii, 546, 663, 818. J. des. Fab. de Sucre, ix, 329. Dingl. J., cxcii, 158. Monit. Scientif., xi, 301, 450. Z. C., (1869,) 224. Bull. Soc. d'Enc., lxviii, 310. Instit., (1869,) 82, 110, 117. Berl. Ber., ii, 104. J. Pharm., (4,) x, 54, 109. J. B., (1869,) 1111.
1869	Dubrunfaut	Sugar, glucose, and saccharimetry	C. R., lxviii, 815.
1869	Dubrunfaut	Constitution of invert sugar; reply to Maumené.	Sugar-Cane, i, 305; ii, 31. C. R., lxix, 1151. Pol. Centr., (1870,) 575.
1869	Manbré	Manufacture of starch-sugar under pressure.	N. Rep. Pharm., xvii, 558. Monit. Scientif., xi, 605. Dingl. J., cxci, 393. Ch. News, xx, 34. J. Pharm., (4,) x, 435.
1869	Maumené	Proportion of levulose in invert sugar	C. R., lxix, 1008, 1154, 1242, 1306. Bull. Soc. Chim., (2,) xiii, 349. J. Pr. Ch., cviii, 315. Z. C., (1870,) 149. Ch. News, xx, 262. Sugar-Cane, i, 304. Pol. Centr., (1870,) 343. Berl. Ber., ii, 744. J. B., (1869,) 743.
1869	Musculus	Starch splits into one part grape-sugar and two of dextrine under the action of diastase.	C. R., lxviii, 1267. J. Pharm., (4,) x, 11. Z. C., (1869,) 446. J. B., (1869,) 745.
1869	Petit	Probable transformation of the acid of grapes into sugar.	C. R., lxix, 760. J. B., (1869,) 799.
1869	Pierre and Puchot	Products of fermentation of sugar-beet juice.	C. R., lxix, 95.
1869	Schützenberger	Action of anhydrous acetic acid upon glucose.	C. R., lxviii, 814. A. C. P., clx, 86. Berl. Ber., ii, 163, 556. Z. C., (1869,) 264. C. C., (1869,) 681. Bull. Soc. Chim., (2,) xii, 107, 204. J. B., (1869,) 750.
1869	Vogel, A	Testing glycerine for sugar by molybdates.	N. Rep. Pharm., xviii, 24. Ch. News, xix, 167. Ind. Zeit. Z. Anal. C., viii, 209. J. B., (1869,) 949.
1869	Wiesner	The activity of yeast-cells affected by adding or subtracting water.	Wien. Akad. Ber, lix, (2te Ab.,) 495. J. Pr. Ch., cvi, 252.
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1870	Colly	Action of acetylchloride and other haloids on glucose.	C. R., lxx, 401. J. Pharm., (4,) xii, 31. Berl. Ber., iii, 212; iv, 933; vi, 197. A. C. P., (4,) xxi, 363. Z. C., (1870,) 250. Ch. News, xxiv, 35. Ch. C., (1870,) 178. Bull. Soc. Chim., (2,) xiv, 58. J. B., (1870,) 841.
1870	Dupré	Estimating three kinds of sugar in one solution optically.	Ch. News, xxi, 97. C. C., (1870,) 751. Sugar-Cane, ii, 218. Z. Anal. Ch., ix, 501. Dingl. J., cxcvi, 537. J. B., (1870,) 1040. Wag. J. B., (1870,) 409.

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1870	Knapp	Estimating grape-sugar with cyanide of mercury.	A. C. P., cliv, 252. C. C., (1870,) 451. Ch. News, xxii, 36. Dingl. J., cxcvi, 538. Sugar-Cane, ii, 468; iv, 615. J. des Fab. Sucre. Z. Anal. C., ix, 395. N. Rep. Pharm., xix, 487. Bull. Soc. Chim., (2,) xiv, 215. Z. C., (1870,) 395, 682. Sc. Amer., xxiii, 121. Buchner's Rep., xix, 487. J. Pharm., (4,) xii, 378. Bayer, Ind. and Gewerb., (1870,) 241. Pol. Centr., (1871,) 270. J. B., (1870.) Wag. J. B., (1870,) 410.
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1870	Leussen	Fehling's, Knapp's, and Gentele's estimation of sugar.	Z. Anal. C., ix, 453. J. B., (1870,) 1034. Z. Anal. C., ix, 20, 224.
1870	Löwe	Glycerine-copper solution for estimating sugar.	J. Pharm., (4,) xii, 442. Sc. Amer., xxv, 40. Pol. Notizbl., (1870,) 124. Z. C., (1870,) 509.
1870	Ludwig	Crystals of grape-sugar on dried prunes and in preserved prunes.	Bull. Soc. Chim., (2,) xiv, 49. N. Rep. Pharm., xix, 761. J. B., (1870,) 1036. Wag. J. B., (1870,) 407. C. C., (1870,) 532.
1870	Marignac	Density and expansion of sugar solutions.	Arch. Sci. Bib. Unio., Nov., 1870. A. C. P., (4,) xxii, 437.
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1870	Maumené	On the nature of invert sugar	C. R., lxx, 53. J. Pharm., (4,) xii, 227.
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1870	Midy	Estimating glucose in commercial sugar with copper solution.	Rev. Heb. Chim., July 28, 1870. Ch. News, xxii, 120. Am. Chem., i, 188.
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1870	Schubert	Estimation of sugar in wine	Verh. Phys. Med. Ges. Würz., (N. F.,) i, 184. N. Jahrb. Pharm., xxxiii, 129. Z. Anal. C., ix, 112. J. B., (1870,) 1043.
1870	Schwarzer	Conversion of starch by diastase	J. Pr. Ch., cix, 212. Dingl. J., cxcviii, 321. Bull. Soc. Chim., (2,) xiv, 400. C. C., (1870,) 295. J. B., (1870,) 854.
1871	Bouchardat	Transformation of glucose into monotomic and hexatomic alcohols.	C. R., lxxiii, 1008. J. Pharm., (4,) xiv, 424. Bull. Soc. Chim., (2,) xvi, 38. Ch. News, xxiv, 240. Z. C., (1871,) 431. J. B., (1871,) 790.
1871	Campani	Testing urine for glucose with acetate of lead and copper.	Arch. Pharm., cxcviii, 51. Berl. Ber., iv, 415. Z. Anal. C., xi, 321. Pol. Notizbl., xxvii, 47. Les Mondes, xxxii, 74. Ch. News, xxviii, 170. J. B., (1871,) 968.
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1871	Gill	Effect of acetate of lead on rotatory power of glucose solutions.	Ch. News, xxiii, 139. Berl. Ber., iv, 283. J. Ch. Soc., (2,) ix, 85, 91. Z. Anal. C., x, 490. C. C., (1871,) 237. Sugar-Cane, iii, 303. Les Mondes, xxxiii, 778. J. B., (1871,) 965. Wag. J. B., (1871,) 599.
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1871	Hoppe-Seyler	Lactic acid from glucose by alkalies without fermentation.	Berl. Ber., iv, 346. Z. C., (1871,) 507. C. C., (1871,) 389. Bull. Soc. Chim., (2,) xv, 231. A. C. P., (4,) xxv, 193. J. B., (1871,) 561.
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1871	Maly	Trommer's test in urine	Wien. Akad. Ber., lxiii, (2te Ab.,) 477. Z. Anal. C., x, 382. J. Pharm., (4,) xvi, 147. C. C., (1871,) 601. J. B., (1871,) 968.
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1871	Pillitz	Estimation of sugar	Z. Anal. C., x, 456.
1871	Raoult	Conversion of cane into grape sugar by light.	C. R., lxxiii, 1049. J. Pharm., (4,) xiv, 415. A. C. P., (4,) xxiii, 291. A. C. P., clxii, 272. Dingl. J., cciii, 79. C. C., (1871,) 757. Pol. Centr., (1872,) 79. Z. C., (1871,) 536. Ch. News, xxiv, 252. J. B., (1871,) 795.
1871	Sachsse	Action of glucose on aniline	Berl. Ber., iv, 836. J. B., (1871,) 797.
1871	Schiff	Action of glucose on aniline	Berl. Ber., iv, 908. A. C. P., cxl, 123; cliv, 30. J. B., (1871,) 798.
1871	Seegen	No reliable test for traces of sugar in urine.	Wien. Akad. Ber., lxiv, (2te Ab.,) 9. Z. Anal. C., x, 501. J. Pharm., (4,) xvi, 364. Pharm. J. and Trans., (3,) ii, 202. J. B., (1871,) 968.
1871	Vivien	Analysis of sirups	Ch. News, xxiii, 281. Am. Chem., i, 258. C. C., (1871,) i, 455.
1872	Barfoed	No sugar formed when dextrine ferments.	J. Pr. Ch., cxiv, (N. S., vi,) 334. Arch. Pharm. J. Pharm., (4,) xviii, 248. J. B., (1872,) 771.
1872	Borodulin	Cane-sugar not converted into inactive sugar by silver nitrate.	Berl. Ber., v, 477. J. B., (1872,) 783.
1872	Bouchardat	Isopropylic, ethylic, and hexylic alcohol formed by hydrogenating the glucoses.	A. C. P., (4,) xxvii, 87. Berl. Ber., v, 324.
1872	Brunner	Estimating sugar with Fehling's solution.	Z. Anal. C., xi, 32. C. C., (1872,) 392. J. B., (1872,) 931. Wag. J. B., (1872,) 515.
1872	Chancel	Sugar solutions contract at the moment of inversion.	C. R., lxxiv, 376. J. B., (1872,) 1035.
1872	Dumas	On ferments belonging to the diastase group.	C. R., lxxv, 295. Bull. Soc. d'Enc., lxxii, 49. Monit. Scientif., (1872,) 744. Ch. News, (1872,) 82. C. C., (1872,) 567. Wag. J. B., (1872,) 542.
1872	Feltz	Uncertainty of Trommer's test for estimating glucose in saccharose.	C. R., lxxv, 962; lxxvi, 1140. Berl. Ber., v, 881. Dingl. J., ccvi, 384. J. B., (1872,) 783, (1873,) 966.

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Date.	Author.	Subject.	References.
1872	Feltz	Action of crystallized sugar on tartrate of copper.	C. R., lxxv, 960; lxxvi, 1140. Dingl. J., ccvi, 384. J. Pharm., (4,) xvii, 42; xviii, 98.
1872	Feltz	Alkaline treatment of sirups increases the quantity of glucose.	Sugar-Cane, iv, 225.
1872	Krötke	Manufacture of starch-sugar	Dingl. J., ccix, 243. Tech. (Apr., 1872,) Am. Chem., iii, 78. J. B., (1872,) 1022.
1872	Krötke	Preparation of sugar-color from starch-sugar.	Dingl. J., ccix, 241. Pol. Notizbl., xxvii, 179. Pol. Centr., (1872,) 881.
1872	Manassein	Roberts's test for sugar in urine	Centrl. Med. Wissen., (1872,) 551. Z. Anal. C., xii, 236.
1872	Musculus	Conversion of glucose into a substance resembling dextrine.	Bull. Soc. Chim., (2,) xviii, 66. Berl. Ber., v, 648. J. B., (1872,) 773. Wag. J. B., (1872,) 516.
1872	Patterson	Estimation of grape-sugar with Fehling's solution.	Ch. News, xxv, 149. Dingl. J., ccix, 402. Am. Chem., iii, 134. Sugar-Cane, iv, 240. J. B., (1872,) 929.
1872	Possoz	Estimating sugar with copper	C. R., lxxv, 1836. J. B., (1872,) 931.
1872	Scheibler	Crystals of glucose, and sodium chloride to standardize with.	Berl. Ber., v, 928. Dingl. J., ccvi, 386.
1872	Schulze and Märcker	Transformation of starch by diastase	Naturf., (1872,) No. 27. Dingl. J., ccvi, 245. J. B., (1872,) 771.
1872	Schwarz	Pure glucose obtained by dissolving in alcohol and adding hydrochloric acid.	Pol. Notizbl., (1872,) 383. Berl. Ber., v, 802. Dingl. J., ccv, 427. Pol. Centr., (1873,) 275. Z. Anal. C., xii, 218. N. Jahrb. Pharm. J. Pharm., (4,) xviii, 248. J. B., (1872,) 1036.
1872	Seegen	Detecting traces of sugar in urine	Arch. Physiol., v, 375. Br. Med. J. Ch. News, xxv, 272. Z. Anal. C., xi, 355. J. B., (1872,) 943.
1872	Softmann	Estimating water and fruit-sugar in cane-sugar.	Z. Zuckerfabr., xii, 214.
1872	O'Sullivan	Products of the conversion of starch	J. Chem. Soc., (2,) x, 579. Am. Chem., iii, 130. C. C., (1872,) 628. Dingl. J., ccvi, 245. Ch. News, xxv, 250. J. B., (1872,) 771.
1872	Weber	Starch sugar and sirup	Soc. for Prom. Trade in Prussia. Sc. Amer., xxviii, 181.
1872	Weil	Volumetric estimation of sugar	A. C. P., (4,) xxvii, 109. Dingl. J., ccvii, 409. Z. Anal. C., xi, 284. J. B., (1872,) 931.
1872		History of grape-sugar manufacture	J. App. Sci. Monit. Scientif., (3,) iii, 426. J. B., (1873,) 1069.
1873	Barfoed	Testing for grape-sugar in presence of dextrine with copper acetate.	Z. Anal. C., xii, 27. Monit. Scientif., xvi, 751. J. B., (1873,) 969.
1873	Borodulin	Action of potassium permanganate on invert sugar.	Berl. Ber., vi, 1207. J. B., (1873,) 832.
1873	Classen	Action of water and neutral salt solutions on cane-sugar.	Sugar-Cane, v, 557. Les Mondes, xxxiii. Ch. News, xxix, 93.
1873	Deherain	Absorption of nitrogen by alkaline solution of glucose and humus.	C. R., lxxvi, 1390. Berl. Ber., vi, 679. Bull. Soc. Chim., (2,) xix, 538. J. B., (1873,) 1044.

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Date.	Author.	Subject.	References.
1873	Jacobsen	No glucose in human bile	Berl. Ber., vi, 1027. J. B., (1873,) 877.
1873	Jean	Use of ammonia-chloride of silver for estimating grape-sugar.	Z. Anal. C., xii, 111. J. B., (1873,) 966.
1873	Jouglet	Artificial beet-sugar	Assemblée Nationale. Sugar-Cane, v, 505. Les Mondes, xxxi, 596, 676. Ch. News, xxviii, 110.
1873	Krause	Fehling's test, titrating excess of copper with cyanide.	N. Rep. Pharm., xxii, 89. C. C., (1873,) 185. Z. Anal. C., xii, 323. J. B., (1873,) 966.
1873	Loiseau	Influence of the quantity of soda in Fehling's solution.	C. R., lxxvi, 1602. Berl. Ber., vi, 970. J. B., (1873,) 965.
1873	Loiseau	Barreswil's method	C. R., lxxvi, 1602; lxxix, 1263. J. Pharm., (4,) xviii, 169.
1873	Margueritte	Preparation of grape-sugar	Bull. Soc. Chim., xix, 89. Berl. Ber., (1873,) 89. Wag. J. B., (1873,) 577.
1873	Mertens	Estimating glucose with mercury cyanide.	Z. Anal. C., xiii, 76. Berl. Ber., vi, 440. C. C., (1873,) 537. J. B., (1873,) 965. Wag. J. B., (1873,) 578.
1873	Mohr	Estimating grape-sugar with permanganates.	Z. Anal. C., xii, 296. Z. für Zucker-Ind. Bull. Soc. Chim., xxi, 499. Am. Chem., v, 150. J. B., (1873,) 966. Wag. J. B., (1874,) 694.
1873	Ondemans	Effect of inactive substances on the rotation of optically active bodies.	Pogg., cxlviii, 337. A. C. P., clxvi, 65. J. R. C., i, 486. J. B., (1873,) 169. Ch. News, xxvii, 300.
1873	Possoz	Action of glucose on copper solutions treated with CO_2 or $KHCO_3$.	Berl. Ber., vi, 34.
1873	Possoz	Use of copper in estimating sugar	Dingl. J., ccvii, 152.
1873	Prazmowski	Modification of optical saccharimetry	C. R., lxxvi, 1212. J. B., (1873,) 175.
1873	Riffard	Estimating sugar with iron	C. R., lxxvii, 1103. J. B., (1873,) 964.
1873	Salkowski	Compounds of grape-sugar with copper	Archiv. Physiol., vi, 220. Z. Anal. C., xii, 98. J. B., (1873,) 967.
1873	Smith, H. A	Conversion of starch into sugar in the human body.	Sugar-Cane, v, 408, 445.
1873		Production of glucose in animals	Eng. Mech. Sugar-Cane, v, 119.
1873	Statistics	Number of starch-sugar factories in Germany.	J. B. Zuckerfab., vols. xiv to xviii. Wag. J. B., (1875,) 805.
1874	Bouchardat	Butyric fermentation of glucose	C. R., lxxviii, 1145. Ch. News, xxix, 273. J. B., (1874,) 950.
1874	Braun	Picric-acid test for grape-sugar in cane-sugar.	Ind. Blätter, (1874,) No. 39. Pol. Notizbl., xxix, 365.
1874	Dubrunfaut	Maltose	A. C. P., (3,) xxi, 178.
1874	Friedländer	Possible theoretical yield of alcohol from grape and cane sugar and starch.	C. C., (1874,) 651.
1874	Gautier	Formation of an isomeric saccharose	Berl. Ber., vii, 1549. Bull. Soc. Chim., (2,) xxii, 145. C. C., (1874,) 707. J. B., (1874,) 883.
1874	Hollefreund	Sugar from potatoes, maize, and grain	Dingl. J., ccxi, 327. J. B., (1873,) 1179.
1874	Krause	Estimating grape-sugar in beet-root	Schweiz. Wochensch. Pharm., (1874,) 17. Bull. Soc. Chim., xxi, 420. Ch. News, xxx, 81. Z. Anal. C., xiii, 244. J. B., (1874,) 1027.
1874	Laborde	Cane-sugar and glucose absorb dry ammonia and become liquid.	Monit. Scientif., xvi, 134. C. R., lxxviii, 82. J. B., (1874,) 883.

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Date.	Author.	Subject.	References.
1874	Lagrange	A Fehling's solution made with dry neutral tartrate of copper, &c.	C. R., lxxix, 1005. Dingl. J., ccxv, 361. Monit. Scientif., xvii, 538. Am. Chem., v, 428; vi, 467.
1874	Laurent	A new saccharimeter with monochromatic light.	C. R., lxxviii, 349. Bull. Soc. Chim., (2,) xxi, 243. J. B., (1874,) 166.
1874	Macagno	Estimating glucose with mercuric chloride.	C. C., (1874,) 314. Gazz. Chim. Ital., (1874,) 267. Berl. Ber., vii, 359. J. B., (1874,) 1027.
1874	Maly	Grape-sugar converted into sarcolactic acid by the mucous membrane of the stomach.	A. C. P., clxxiii, 227. Berl. Ber., vii, 1567. J. B., (1874,) 926.
1874	Milne	Estimating fruit-sugar in raw sugars	Ch. News, xxx, 104. J. B., (1874,) 1027.
1874	Musculus	Soluble starch	Bull. Soc. Chim., (2,) xxii, 26. A. C. P., (5,) ii, 385. J. B., (1874,) 881.
1874	Péligot	Saccharine	C. R., lxxx; xc, 1141, 920.
1874	Poehl	Glucose in rye and wheat flour	Pharm. Z. Russ., xiii, 321. Pol. Notizbl., xxxi, 23. C. C., (1874,) 520. Am. Chem., v, 229. J. B., (1874,) 881.
1874	Riffard	Estimating sugar with iron	Monit. Scientif., xvi, 83.
1874	Schiff	Estimating glucose with $HgCl_2$	Berl. Ber., vii, 359, (footnote.)
1874	Schulze and Urich	Maltose	Berl. Ber., vii, 1048. Pol. Centr., (1874,) 1374. Z. Anal. C., xiii, 457. J. B., (1874,) 884.
1874	Sestini, Torre, and Baldi.	Percentage of grape-sugar in Italian wines.	Berl. Ber., vii, 1295. J. B., (1874,) 1174.
1874	Stolba	Selenious acid reduced by grape-sugar.	C. C., (1874,) 115.
1874	Stolba	Reduction of telluric acid by grape-sugar.	Dingl. J., ccxi, 324.
1874	O'Sullivan and Schulze	Maltose	Monit. Scientif., (3,) iv, 210. Dingl. J., ccxiv, 339. Berl. Ber., vii, 1047. J. B., (1874,) 884.
1874		Chemical sugar	Sc. Amer., xxx, 7.
1874		Adulterated sirups	Sugar-Cane, vi, 58.
1875	Béchamp	Glucose in fermented liquids	J. Pharm., (4,) xxi, 458. Am. Chem., vi, 195.
1875	Bente	Glucose formed by the action of hydrochloric acid on wood.	Berl. Ber., viii, 476. J. B., (1875,) 785. (Erdmann's A. C. P. V., sup., 223.)
1875	Behr, A	Inversion of sugar by various mineral and organic acids.	Centr. Agr. Chem., Feb., 1875. Ch. News, xxxi, 218.
1875	Bernard	Starch, dextrine, and three kinds of sugar in beet-leaves.	C. R., lxxxi, 1231. J. B., (1875,) 1122.
1875	Bondonneau	Pure dextrine formed by the action of diastase.	Bull. Soc. Chim., xxiii, 98. Ch. News, xxxi, 182.
1875	Bondonneau	Saccharification of amylaceous substances.	C. R., lxxxi, 972, 1210. Bull. Soc. Chim., xxv, 2. Dingl. J., ccxx, 75, 78. J. R. Ch., iii, 143.
1875	Brücke	New method of applying Böttger's sugar-test.	Wien. Akad. Ber., lxxii, (2te Ab.,) 115. Pol. Notizbl., xxx, 339. J. B., 986.
1875	Champion and Pellet	Decomposition of Fehling's solution, and estimating glucose in sugar.	C. R., lxxx, 181. J. Pharm., (4,) xxi, 212. Bull. Soc. Chim., (2,) xxiv, 444. Monit. Scientif., (3,) v, 263. J. B., (1875,) 984.
1875	Chancel	On the dextro-rotatory reducing substance found by Béchamp in wine.	C. R., lxxxi, 46. J. B., (1875,) 987.
1875	Davin	Glucose does not prevent the crystallization of cane-sugar.	La Sucrerie Ind., ix, No. 10. Am. Chem., v, 391.

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1875	Durin	Effect of grape-sugar and salts on crystallization of saccharose.	Berl. Ber., viii, 1362. C. R., lxxxi, 621. Dingl. J., ccxix, 521. J. Pharm, (4,) xxiii, 110. Monit. Scientif., xvii, 1066. Bull. Soc. Chim., (2,) xxv, 139. Org. C. V. Rübenz., (1876,) v, 566. J. B., (1875,) 1126. Wag. J. B., (1876,) 743.
1875	Epstein and Müller	Acids check the formation of diabetic sugar.	Berl. Ber., viii, 679. J. B., (1875,) 866.
1875	Fileti	Action of potash and copper acetate on glucose.	Gazz. Chim. Ital., (1875,) 28. Berl. Ber., viii, 441. Ch. News, xxxi, 218. J. B., (1875,) 793.
1875	Fleury	Inversion of cane-sugar by acids and salts.	C. R., lxxxi, 823. A. C. P., (5,) vii, 381. Dingl. J., ccxix, 436. Org. C. V. Rübenz., (1876,) v, 127. J. B., (1875,) 802. Wag. J. B., (1876,) 748.
1875	Hoppe-Seyler	Rotatory coefficient of grape-sugar	Z. Anal. C., xiv, 303. J. B., (1875,) 131.
1875	Kastner	Quantitative estimation of tellurium with grape and inverted sugar.	Z. Anal. C., xiv, 142. J. B., (1875,) 921.
1875	Kreusler	Inversion of sugar by light	Berl. Ber., viii, 96. Z. Anal. C., xiv, 197. J. B., (1875,) 802.
1875	Külz	Use of grape-sugar in diabetes	Schmidt's Jahrb. Med., clxviii, 83.
1875	Lagrange	Effect of salts on the crystallization of sugar.	C. R., lxxxi, 1249. Bull. Soc. Chim., (2,) xxv, 383. Ch. News, xxxiii, 33. Berl. Ber., ix, 189. Dingl. J., ccxix, 363. Org. C. V. Rübenz., (1876,) v., 136. J. B., (1875,) 1127. Wag. J. B., (1876,) 741.
1875	Mategczek	Estimation of dextrose and levulose	Zeitsch., xxv, 873. J. B. Zuck. Fab., xv, 141. Org. C. V. Rübenz., (1876,) v, 35. Wag. J. B., (1876,) 765.
1875	Maumené	Inverted sugar a mixture of glucose, chylariose, &c.	C. R., lxxx, 1139. J. Pharm., (4,) xxii, 47. Les Mondes, xxxvii, 127. J. B., (1875,) 793.
1875	Maumené	Invert sugar more easily incinerated than cane-sugar.	C. R., lxxx, 1139. Ch. News, xxxi, 250.
1875	Maumené	Glucose in invert sugar	Berl. Ber., viii, 698.
1875	Mercadante	Formation of sugar in fruits	Gazz. Chim. Ital., (1875,) 125. Berl. Ber., (1875,) 822. Ch. News, xxxii, 19. J. B., (1875,) 834.
1875	Milne	Estimating fruit-sugar in raw sugar	Dingl. J., ccxv, 284.
1875	Missaghi	Decomposition of Fehling's solution	Gazz. Chim. Ital., (1875,) 414. J. B., (1875,) 985.
1875	Neubauer	Commercial starch-sugars	Weinbau., (1875,) Nos. 1, and 2. Bay. Bierbrauer, (1875,) 129. Wag. J. B., (1875,) 806.
1875	Neubauer	Recognizing grape-sugar in gallized wine.	Berl. Ber., viii, 1285. J. B., (1875,) 988.
1875	Neubauer	Effect of antiseptics on the estimation of urea and sugar.	C. C., (1875,) 263. Z. Anal. C., xiv, 405.
1875	Pasteur	Duchartre's theory of the conversion of starch into sugar.	C. R., lxxxi, 1071. J. B., (1875,) 1122.

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1875	Petit	Transformation of starch by diastase	Bull. Soc. Chim., (2,) xxiv, 519. C. R., lxxxi, 589. C. C., (1876,) 83. Ch. News, xxxiii, 10. J. B., (1875,) 788. Wag. J. B., (1877,) 644.
1875	Salkowski	Sugar in urine	Arch. Physiol., vi, 220. Monit. Scientif., xvii, 337. Ch. News, xxxi, 261.
1875	Seegen	Reducing action of sugar and uric acid in the cold.	Centr. Med. Wissen., (1875,) 323. Z. Anal. C., xiv, 377.
1875	Strohl	Estimating very small amount of glucose in urine.	J. Pharm., (4,) xxi, 191. Z. Anal. C., xiv, 407.
1875	Tremain	Result of analyses of different sugars and sirups.	Z. Ver. Rübenz. Ind., (1875,) 127. Dingl. J., ccxviii, 375. J. B., (1875,) 1128.
1875	Vierordt	Estimating glucose with excess of copper, and estimating excess by the spectroscope.	A. C. P., clxxvii, 32.
1876	Anthon	Dextrine in different kinds of commercial starch-sirup.	Z. Oest. Apoth. Ver., (1876,) 429. Dingl. J., ccxix, 437. Sc. Amer., xxxiv, 342. Z. Anal. C., xvi, 124. Org. C. V. Rübenz., v. 185. Ind. Blätter, (1876,) 374. Bull. Soc. Chim., (2,) xxvi, 233. J. B., (1876,) 837.
1876	Anthon	Caramel from starch-sugar	Org. C. V. Rübenz., v, 344. Wag. J. B., (1876,) 770.
1876	Anthon	Gypsum in starch-sugar	Org. C. V. Rübenz., (1876,) v, 563. Wag. J. B., (1876,) 774.
1876	Bernard	Sugar in the blood	C. R., lxxxii, 777. Ch. News, xxxiii, 191. J. Pharm., (4,) xxiv, 166 238. J. B., (1876,) 922.
1876	Böttger	Determining cane and grape sugar in glycerine with molybdate of ammonia.	Arch. Pharm., ccviii, 91. Pol. Notizbl., xxxi, 79. Z. Anal. C., xvi, 508. C. C., (1876,) 662. Ch. Ind., i, 102.
1876	Boussingault	Two kinds of sugar in petals of flowers	C. R., lxxxiii, 978. J. B., (1876,) 868.
1876	Boutleron	Constitution of glucose	Bull. Soc. Chim., (2,) xxv, 393.
1876	Brumme	Estimating sugar with mercury cyanide	Pharm. Zeit. Russ., (1876,) 549. J. Pharm., (4,) xxvii, 458. Z. Anal. C., xvi, 121.
1876	Fitz	Action of coulose towards mucor racemosus, (not mucado.)	Berl. Ber., ix, 1353. J. B., (1876.) 950.
1876	Fleury	Heat from the inversion of sugar	Sc. Amer. Sup., i, 124.
1876	Fuldakowski	Formation of grape-sugar from milk by acid.	Berl. Ber., ix, 43, 278, 1602. J. B., (1876,) 841.
1876	Leuberg and Georgiewsky.	Unlike effect of saliva on the different starches.	Berl. Ber., ix, 76. J. B., (1876,) 836.
1876	Girard	Saccharose converted into reducing-sugar in refining.	C. R., lxxxiii, 196. Dingl. J., ccxxii, 399. Monit. Scientif., (1876,) 954. J. Pharm., (4,) xxiv, 454. Sugar-Cane, viii, 658. Ch. News, xxxiv, 71. Org. C. V. Rübenz., v, 569. Berl. Ber., (1876,) 1431. J. B., (1876,) 1141. Wag. J. B., (1876,) 748.
1876	Girard and Laborde	Optical inactivity of reducing-sugar in commercial article.	C. R., lxxii, 214, 417. Dingl. J., ccxx, 257. J. Pharm., (4,) xxiii, 198. J. B., (1876,) 841, 843.
1876	Haarstick	Detecting grape-sugar in beer	C. C., (1876,) 201. Dingl. J., ccxx, 565. Z. Anal. C., xv, 468. J. B., (1876,) 1036.

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1876	Haarstick	Analyses of commercial grape-sugars	C. C., (1876,) 13. J. B. Zuck. Fab., xvi, 176.
1876	Kolli	Constitution of grape-sugar	Berl. Ber., ix, 77. J. B., (1876,) 839.
1876	König and Rosenfeld	Derivatives of glucose	Wien. Akad. Ber., lxxiv, 756. C. C., (1877,) 276. Berl. Ber., x, 871.
1876	Krusemann	Levulose from inuline; treatment with chlorine and silver oxide.	Berl. Ber., ix, 1469. J. B., (1876,) 839.
1876	Krusemann	The alcohols obtained by reduction of levulose or glucose are identical with mannite.	Berl. Ber., ix, 1486.
1876	Külz	No sugar in normal urine	Pflüg. Arch., xiii, 269. C. C., (1877,) 8.
1876	Leuberg and Georgiewsky.	Formation of grape-sugar from different kinds of starch by the saliva.	Berl. Ber., ix, 76. J. B., (1876,) 836.
1876	Maumené	Constituents of invert sugar and their presence in commercial sugar.	C. R., lxxxii, 336, 570. Dingl. J., ccxx, 547. Les Mondes, xxxix, 282. J. B., (1876,) 842.
1876	Müntz, Girard, and Laborde.	Inactive glucose and mannite in raw sugar.	Berl. Ber., ix, 351. C. R., lxxxii, 210, 214, 217.
1876	Müntz	Reducing-sugar in cane-sugar	C. R., lxxxii, 210, 517. Org. C. V. Rübenz., v, 1134. Dingl. J., ccxx, 463. J. Pharm., (4,) xxiii, 170. Les Mondes, xxxix, 451. Monit. Scientif., (1876,) 738. Bull. Soc. Chim., xxvi, 91. Berl. Ber., ix, 350. J. B., (1876,) 842. Wag. J. B., (1876,) 749.
1876	Neubauer	Pure grape-sugar from cane-sugar	Pharm. Centrlh., xvii, 219. Z. Anal. C., xv, 192. C. C., (1876,) 516. J. Pharm., (4,) xxiv, 265. Pol. Notizbl., xxxi, 168. J. B. Zuck. Fab., xvi, 165. Wag. J. B., (1876,) 773.
1876	Neubauer	Unfermentable substance in commercial grape-sugar.	Z. Anal. C., xv, 195. Berl. Ber., viii, 1285. Dingl. J., ccxix, 146. J. B., (1876,) 1035.
1876	Neubauer	Detection of grape-sugar in gallized wine.	Z. Anal. C., xv, 188. Dingl. J., ccxix, ccxx, 565. J. B., (1876,) 1035.
1876	Perrot	Volumetric estimation of sugar with copper and potassic cyanide.	C. R., lxxxiii, 1044. J. Pharm., (4,) xxvi, 43. J. B., (1876,) 1033.
1876	Reyard	Glucose by electrolysis of glycerine	C. R., lxxxii, 562. Bull. Soc. Chim., (2,) xxvi, 285. J. R. Ch., iv, 157. J. B., (1876,) 482.
1876	Sachsse	Estimating sugar with mercuric iodide	Sitz. Ber., Nat. Ges., Leipzig, (1876,) 17. Dingl. J., ccxxi, 570. C. C., (1876,) 520. J. B., (1876,) 1033. Wag. J. B., (1876,) 763.
1876	Salomon	Glucose in the residue left by evaporating alcohol.	Med. C. Blatt., xiv, 288. C. C., (1876,) 527.
1876	Soldaini	Permanent solution of copper with carbonate.	Berl. Ber., ix, 1126. Dingl. J., ccxxii, 502. Z. Anal. C., xvi, 248. Gazz. Chim. Ital., (1876,) 322. J. B., (1876,) 1033.
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1876		Glucose for tanning	Sc. Amer. Sup., ii, 203.
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1877	Bachet and Savalle	Conversion of starch into glucose by carbonic acid.	Ch. Ind., i, 269.
1877	Bernard	Formation of sugar in the liver :	A. C. P., (5,) xii, 397. C. R., xli, 4611; xliv, 578. J. Pharm., (4,) xxvii, 260.
1877	Berthelot	Constitution of sugar isomeric with cane-sugar.	C. R., lxxxiv, 38. Bull. Soc. Chim., xxvii. Ch. News, xxxv, 155.
1877	Berthelot	Formation of saccharoses from glucoses.	A. C. P., (5,) xii, 437. Berl. Ber., x, 233.
1877	Boussingault	Saccharine substance in the petals of flowers.	A. C. P., (5,) xi, 130.
1877	Böttger	Use of glucose for reducing metals	Pol. Notizbl., xxxiv, 322. C. C., (1879,) 733. Ch. Zeit. Les Mondes, li, 405.
1877	Corenwinder	Glucose in leaves of sugar-beets; no cane-sugar.	Berl. Ber., x, 93.
1877	Eissfeld and Follenius	Estimation of glucose	Zeit. Ver. Rübenz., 762. Zeit. Ch. Grossgew., ii, 437. Ch. Tech. Reper., (1877,) 599.
1877	Franchimont	Glucose and levulose derivatives	Berl. Ber., x, 994. J. B., (1877,) 901.
1877	Frerichs, Boie, and Stromfeld.	Preparation of flour containing starch, dextrine, and grape-sugar.	Ch. Ind., i, 122. J. B., (1878,) 1155.
1877	Gawalowsky	Glucose in cane-sugar	Zeit. Zuck. Ind. Böhm. Ch. Tech. Reper., (1877.) 599.
1877	Gayon	The transformation of crystalline sugar into inactive glucose caused by a real ferment.	C. R., lxxxiv, 606. Ch. News, xxxv, 155. J. Pharm., (4,) xxv, 510. J. B., (1877,) 1190.
1877	Girard	Estimating the reducing-sugar in commercial products.	C. R., lxxxv, 800. J. Pharm., (4,) xxvii, 363. Ch. News, xxxvi, 223. Dingl. J., ccxxvii, 479. C. C., (1877,) 212. Ch. Tech. Reper., (1877,) 600. J. B., (1877,) 1195.
1877	Grote and Tollens	Production of a trace of levulinic acid from glucose.	Berl. Ber., x, 1444. J. B., (1877,) 715.
1877	Gunning	Glucose in raw sugar	J. Fab. Sucre, xviii. West. Zeit., vi, 638. J. B. Zuck. Fab., xvi, 171; xvii, 175.
1877	Hager	Estimating glucose with mercuric cyanide.	Pharm. Centrlh., xviii, 313. C. C., (1877,) 730. J. B. Zuck. Fab., xviii, 194. Z. Anal. C., xvii, 380.
1877	Halse and Steiner	Analyses of starch-sugar crystallized in transit.	Ch. News, xxxvi, 87. Sugar-Cane, ix, 484. J. B., (1877,) 901.
1877	Halse and Steiner	Optically inactive sugar	Ch. News, xxxvi, 107. Sugar-Cane, ix, 539. Dingl. J., ccxxvii, 111. J. B., (1877,) 902.
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1877	Kosmann	Glycerine transformed into glucose by electrolysis.	Bull. Soc. Chim., (2,) xxviii, 246. J. B., (1877,) 524.
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1877	Neubauer	Detection of grape-sugar in gallized wine.	Z. Anal. C., xvi, 201; xvii. 321. Dingl. J., cexxv, 309; cexxix, 436.
1877	Pagel and Märcker.	Sugar in frozen plants	Dingl. J., cexxv, 306. J. B., (1877,) 1175.
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1877	Strohmer and Klauss	Estimating dextrose with mercurio-potassic iodide.	C. C., (1877,) 713. J. B., (1877,) 1195.
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1878	Froda	Glucose from tannin	Gazz. Chim. Ital., (1878,) 9. Berl. Ber., xi, 346.
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1880	Girard	Preparation of pure levulose.	Bull. Soc. Chim., (2,) xxxiii, 146, 154. C. C., (1880,) 279. J. B., (1880,) 1018. J. B. Zuck. Fab., xx, 166.
1880	Gratama	Gravimetric estimation of glucose	Ch. Zeit., iii, 138.
1880	Grotte and Tollens	Levulinic acid from dextrose.	A. C. P., ccvi, 226.

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Date.	Author.	Subject.	References.
1880	Kiliani	Glycolic acid from levulose and dextrose.	A. C. P., ccv, 191. J. B., (1880,) 768.
1880	Kiliani	Oxidation of dextrose with dilute nitric acid.	A. C. P., ccv, 172.
1880	Kiliani	Inuline, &c	Inaug. Dissert. A. C. P., ccv, 145. Berl. Ber., xiii, 2427. J. B., (1880,) 768.
1880	Külz	Grape-sugar in the dead liver	Pflüg. Arch., xxiv, 52. Berl. Ber., xiv, 367. J. B., (1881,) 1038.
1880	Külz	Maltose	Pflüg. Arch., xxiv, 81.
1880	Landolt	Rotatory power of sugars	Berl. Ber., xiii, 2329. J. B., (1880,) 215.
1880	Lindo	Brucine test for glucose	Ch. News, xxxviii, 145. Z. Anal. C., xix, 357.
1880	Lippmann	Inverting sugar with carbonic acid	Oestr. Zeitsch., xviii, 222. Dingl. J., cexxxvii, 148. Berl. Ber., (1880,) 1823. J. B. Zuck. Fab., xx, 162. J. B., (1880,) 1021.
1880	Märcker	Sugar and maltose from starch	Ch. Zeit., (1880,) 192. J. B., (1880,) 1353.
1880	Montard, Martin, and Richet.	Intervenous injection of sugar and gum.	C. R., xc, 98. J. B., (1880,) 1122.
1880	Musculus, Von Mering, and Bimmermann.	Transformations of starch and glycogen by means of diastase, saliva, &c.	Centrl. Agric. Ch., 1880. Ch. News, xlii, 95.
1880	Nessler	Analysis of potato-sugar for wine	Landw. Vers., xxvi, 207. Wag. J. B., (1880,) 631.
1880	Pavy	Estimating grape-sugar with ammoniacal Fehling's solution.	Ch. News, xxxix, 77. Berl. Ber., xiii, 1884. Z. Anal. C., xix, 98.
1880	Péligot	Lime compounds of levulose	C. R., xc, 153. J. B., (1880,) 1018.
1880	Péligot	Saccharine from glucose	C. R., xc, 1141. J. B., (1880,) 1025.
1880	Planta-Reichenau	Detection of starch-sugar in honey by polarization.	Wag. J. B., (1880,) 621. Schweiz. Wochs. Pharm., (1880,) No. 4. Corr. Bl. Ver. Anal. Ch. Zeit. Oestr. Apoth. Ch. News, xlii, 271. Ch. Zeit., (1880,) 391. Z. Anal. C., xx, 465. J. B., (1880,) 1230.
1880	Radziszewski	Phosphorescence of grape-sugar	A. C. P., cciii, 309, 329. J. B., (1880,) 192.
1880	Redfield	Glucose	Sc. Amer. Sup., x, 4126.
1880	Riche	Glucose from maize	J. Pharm., (5,) i, 137.
1880	Scheibler	Converting starch-sugar into saccharine.	Berl. Ber., xiii, 2213.
1880	Schlossing	Action of glucose towards nitrogen	A. C. P., xxiv, 284. Berl. Ber., xiv, 2579.
1880	Schmitz	The non-fermentable portion of grape-sugar poisonous.	J. Pharm., (5,) ii, 43. Ch. News, xlii, 318. Ch. Zeit., (1880,) 804. J. B., (1880,) 1122.
1880	Schreiter	Salicylate of soda in copper solutions	Monit. Scientif., (3,) x, 1034. Pharm. Zeit. J. Pharm., (5,) ii, 312. J. B., (1880,) 1117.
1880	Salkowsky	Silver mirror with cane-sugar	Zeit. Physiol. Ch., iv, 133. J. B. Zuck. Fab., xx, 162. J. B., (1880,) 1020.
1880	Soxhlet	Action of glucose towards alkaline, copper, and mercury solutions.	J. Pr. Ch., cxxix, (xxi,) 227, 242. Berl. Ber., xiii, 827. J. B., (1880,) 1011.
1880	Urich	Inversion of cane-sugar	Berl. Ber., xiii, 1696. J. B., (1880,) 1021.
1880	Valente	Synthesis of glucose from glycerine by Zuino an error.	Berl. Ber., xiii, 2431. Gazz. Chim. Ital., x, 540. J. B., (1880,) 1017.
1880	Willey	Estimation of starch-sugar in cane-sugar.	J. Am. Ch. Soc., (1880,) 387. Berl. Ber., xiv, 1584.
1880	Wolff	Glucose	Sc. Amer. Sup., x, 4127, 4139.
1880		Action of diastase checked by excess of maltose and dextrose.	Brewers' Guardian. Les Mondes, liii, 59.

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Date.	Author.	Subject.	References.
1880	.....	Use of maize in making starch, sugar, spirits, and beer.	Dingl. J., ccxxxviii, 488.
1880	.....	Glucose for confectionery.....	Confectioners' Jour.
1880	.....	Glucose from rags	Sc. Amer., xlii, 72. Rev. Ind. Sc. Amer., xlii, 200.
1880	.....	Adulteration of sugar and candy.....	Dingl. J., ccxxxv, 140.
1881	Allihn.....	Saccharification of starch at high temperature.	J. Pharm., (5,) iii, 588. J. Pr. Ch., (2,) xxii, 46. Z. Anal. Ch., xx, 452.
1881	Böttinger.....	The sugar of oak-bark tannin	Berl. Ber., xiv, 2390, 1596. J. R. Ch., ix, 454. J. B., (1881,) 992.
1881	Bontroux.....	A new fermentation of glucose.....	J. Pharm., (5,) iii, 347.
1881	Casamajor.....	Detection of starch-sirup in sugar-house molasses.	J. Am. Ch. Soc., ii, 429. Ch. News, xliv, 265. Pol. Notizbl., xxxvi, 32. Z. Anal. C., xxi, 144; xxii, 280. Arch. Pharm., (3,) xix, 393. J. Pharm., (5,) iii, 349. J. R. Ch., ix, 452.
1881	Degener.....	Reducing power of different sugars.....	Zeit. Ver. Rübenz., (1881,) 349. C. C., (1881,) 470. Berl. Ber., xv, 396. J. B., (1881,) 980.
1881	Delarue	Conversion of starch into sugar by oxalic acid.	C. C., (1881,) 404. J. B., (1881,) 987.
1881	Dubrunfaut	Converting starch into maltose by malt-extract, ("maltose.")	Ch. Zeit., vi, 1391. Wag. J. B., (1881,) 583.
1881	Dudley.....	Basic nitrate of bismuth test.....	Am. Ch. J., ii, 47. Berl. Ber., xiv, 1121. Z. Anal. C., xx, 117.
1881	Emmerling.....	A reducing substance formed by the action of KHO on fused glucose.	Pflüg. Arch., xxiv, 184. Berl. Ber., xiv, 1005. J. R. Ch., ix, 452. J. B., (1881,) 983.
1881	Fresenius	Reaction of different sugars on copper solutions, also Hg.	Z. Anal. Ch., xx, 425. Z. Anal. Ch., xx, 447.
1881	Gayon.....	Research on formation of reducing-sugar in cane-sugar.	Ann. Agronom. J. Pharm., (5,) v, 440.
1881	Habermann and Hönig.	Action of copper hydrate on certain sugars.	Monatsch. Ch., iii, 651. Z. Anal. C., xx, 565. Wien. Akad. Ber., (1881,) 18. C. C., (1881,) 119. Berl. Ber., xv, 2624. J. R. Ch., ix, 451. J. B., (1881,) 981.
1881	Herzfeld.....	Maltose..	Ber. Physiol. Lab. Halle, iv, 15. Sc. Amer. Sup., xi, 4323. Wag. J. B., (1882,) 685.
1881	Jungfleisch and Lefranc.	Levulose from inuline	C. R., xciii, 547. J. Pharm., (5,) iv, 437. C. C., (1881,) 734. Dingl. J., ccxliii, 86.
1881	Kretschmar	Estimating glycogen, dextrine, and starch.	Pflüg. Arch., xxiv, 134. Z. Anal. C., (1881,) 601. J. B., (1881,) 1213.
1881	Külz.....	Sugar in urine after taking acids.....	Berl. Ber., xiv, 367.
1881	Kunheim.....	Removing gypsum with barium oxalate	Ch. Ind., iv, 389.
1881	Leube	Changes that cane-sugar undergoes in the stomach.	Arch. Path. Anst., lxxxviii, 222. N. Y. Med. J., xxxvi, 444. Berl. Ber., xv, 1347.
1881	Laugbeck	Bitter substances developed during fermentation.	Sci. Amer., (1881,) May 21.
1881	Lippmann	Presence of saccharine in osmosed sugar.	J. Pharm., (5,) iii, 65. Berl. Ber., xiii, 1826.
1881	Lippmann	Cane-sugar inverted by carbonic acid ...	J. Pharm., (5,) iii, 63. Berl. Ber., xiii, 1822. Z. Anal. C., xxii, 117.
1881	Maumené	Inverting sugar with carbonic acid.....	Bull. Soc. Chim., xxxvi, 652. Berl. Ber., xv, 252.
1881	Von Mering.....	Grape-sugar from starch by means of diastase.	Z. Phys. Ch., v, 185. J. B., (1881,) 1144.

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Date.	Author,	Subject.	References.
1881	Meissl	Maltose	J. Pr. Ch., (2,) xxv, 114. Z. Anal. C., xxii, 114. Berl. Ber., xv, 944.
1881	Musculus and Meyer	Converting glucose into gamma-dextrine with sulphuric acid.	C. R., xcii, 528. Berl. Ber., xiv, 350. C. C., (1881,) 315. Dingl. J., ccxli, 78. Bull. Soc. Chim., (2,) xxxv, 368. Ch. News, xliv, 94. Z. Anal. C., xxi, 577. Z. Physiol. Ch., v, 122. J. R. Ch., ix, 453. J. B., (1881,) 985. Wag. J. B., (1881,) 582.
1881	Nessler and Barth	Optical action of pure and of sugared wines.	Z. Anal. C., xxi, 53.
1881	Nessler	Composition and unwholesomeness of potato-sugar.	Landw. Versuch. Stat., xxvi, 207. Zeit. für Brauwesen, (1881,) 123. Z. Anal. C., xx, 466.
1881	Musculus and Meyer	Achrodextrine and erythrodextrine, a mixture of soluble starch with dextrine.	Z. Phys. Ch., iv, 451. C. C., (3,) xi, 809. Z. Anal. C., xxi, 577.
1881	Musculus and Meyer	Converting grape-sugar into dextrine	Z. Phys. Ch., v, 122. C. R., xcii, 528. Bull. Soc. Chim., (2,) xxxv, 368. C. C., (1881,) 315. J. B., (1881,) 985.
1881	Nencki and Sieber	Decomposition of grape-sugar and uric acid by alkali at 35° to 40° C.	Berl. Ber., xv, 83, 2747. J. Pr. Ch., (2,) xxiv, 498; xxvi, 1. Ch. News, xlv, 87. J. Pharm., (5,) vi, 313. J. B., (1881,) 1032.
1881	Nessler	Injurious effects of potato-starch on the health.	Landw. Vers. Stat., xxvi, 207. Pol. Notizbl., xxxvi, 1. Ch. Zeit. Sc. Amer., xliv, 128. Monit. Scientif., xxiii, 494. Z. Anal. C., xx, 466.
1881	Pellet	Estimating crystalline sugar in solution with glucose and dextrine.	C. R., xci, 308.
1881	Pfeiffer and Tollens	Compounds of alkalies with carbohydrates.	Z. Anal. C., xx, 125. A. C. P., ccx, 285.
1881	Roux	A yeast-cell that causes fermentation in glucose and milk-sugar.	Bull. Soc. Chim., (2,) xxxv, 371. J. B., (1881,) 1146.
1881	St. Danzivillc	Glucose for alcohol from wood	Ch. Zeit., (1881,) 92. J. B., (1881,) 1303.
1881	Salomon	Specific gravity, reducing power, and optical properties of grape-sugar solutions.	Rep. Anal. Ch., (1881,) 309. Berl. Ber., xiv, 2710. J. R. Ch., ix, 451. J. B., (1881,) 982.
1881	Schlossing	Action of glucose towards nitrogen	A. C. P., (5,) xxiv, 284. Berl. Ber., xiv, 2579.
1881	Schumacher-Kopp	Adulteration of honey	Ch. Zeit., (1881,) 646. J. B., (1881,) 1303.
1881	Schmidt	Sugar gives no reaction with fuchsine decolorized by SO_2.	Berl. Ber., xiv, 1850.
1881	Schützenberger	Glucose carbonic acid from invert sugar.	Bull. Soc. Chim., (2,) xxxvi, 144. Berl. Ber., xiv, 2274.
1881	Seegen and Kretschmar	Sugar formed in the liver	Pflüg. Arch., xxiv, 467. Berl. Ber., (1881,) 1575. J. B., (1881,) 1038.
1881	Soxhlet	Pure anhydrous starch-sugar	Dingl. J., ccxlv, 121. Z. Anal. C., xx, 429.
1881	Soxhlet	Estimating maltose	Z. Anal. C., xx, 440.
1881	Soxhlet	Action of sugar towards alkaline, copper, and mercury solutions.	J. Pr. Ch., (2,) xxi, 227. Z. Anal. C., xx, 425.
1881	Sundwik	Specific rotatory power of maltose	Zeit. Phys. Ch., v, 427. Wag. J. B., (1881,) 533.
1881	Valente	Synthesis of glucose; (reply to Professor Zuino.)	Gazz. Chim. Ital., xi, 52. Berl. Ber., xiv, 542; xiii, 2431.

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Date.	Author.	Subject.	References.
1881	West-Knight	Action of dextrine towards maltose in worts.	Analyst., vii, 81, 211. Berl. Ber., xvi, 438.
1881	Wiley	Glucose and amylose	J. Am. Ch. Soc., ii, 397. Sugar-Cane, xiii, 533, 585. Arch. Pharm., (3,) xix, 391. Pharm. J. and Trans., (3,) xii, 140. Ch. Zeit., (1881,) 856. J. R. Ch., ix, 452. J. B., (1881,) 982.
1881	Yoshida	Maltose from Japanese amé	Ch. News, xliii, 29, 54. J. B., (1881,) 984.
1881		Cassava, a new source of glucose	Sc. Amer., xlv, 415; xlvi, 121. Confectioners' Jour.
1881		Glucose sirup a deadly poison	Sugar-Cane, xiii, 367.
1881		Is glucose wholesome?	Sc. Amer., xliv, 128.
1882	Allihn	Reducing power of grape-sugar for copper is not constant.	N. Zeit. Rübenz., ix, 317. Zeit. Ver. Rübenz., (1882,) 608, 865. Ch. Zeit., vi, 995. Wag. J. B., (1882,) 691.
1882	Bauer	Influence of invertine on fermentation of cane-sugar.	Org. Oestr. Ver. Rübenz. Dingl. J., ccxlv, 47.
1882	Behr	Crystallized anhydrous grape-sugar	Berl. Ber., xv, 1104. Ch. News, xlv., 179. Sc. Amer. Sup., xiii, 5378. Am. J. Pharm., (1882.) J. Pharm., (5,) vi, 514; vii, 45. Dingl. J., ccxlv, 121. Wag. J. B., (1882,) 689.
1882	Binz	Injurious effects of potato-brandy	Centr. Allgem. Gesund., (1882,) 131.
1882	Bleile	Conversion of cane-sugar by hydrochloric acid and by the gastric juice.	Med. News, xli, 650.
1882	Boiret	Fehling's solution	L'Union Pharm. J. Pharm., (5,) v, 427.
1882	Casamajor	Detecting starch-sugar in molasses	J. Am. Ch. Soc., iii, 87. Berl. Ber., xv, 1775. Sc. Amer. Sup., xiii, 5026.
1882	Chandler and Ricketts	Determination of artificial grape or starch sugar in cane-sugar.	2d Ann. Report State Board of Health, N. Y., 1882.
1882	Cuisinier	Compound of maltose with lime	La Sucrerie Ind., xix, 244, 278. Wag. J. B., (1882,) 686.
1882	Cuisinier	Newly observed property of glucose; its reducing power.	Sc. Amer., xlvii, 23. Monit. Scientif., (1882,) 150. Ch. Zeit., vi, 474.
1882	Degener	Fluctuations in reducing power of sugars.	Zeit. Ver. Rübenz., xviii, 349. Z. Anal. C., xxii. 444.
1882	Degener	Personal error in polarizing	Ver. Rübenz. Ind., (1882,) 642. Dingl. J., ccxlvii, 165.
1882	Detmer	Use of citric acid when converting starch with diastase.	Zeit. Phys. Ch., vii, 1. Wag. J. B., (1882,) 686.
1882	Dubrunfaut	Starch-sugar	Ch. Zeit., vi, 326. Sc. Amer., xlvi, 313.
1882	Gall	Rotatory power of glucose	Monit. Scientif., Dec., 1882. Ch. News, xlvi, 292.
1882	Hehner	On Pavy's copper solution	Analyst., vi, 218. Z. Anal. C., xxii, 447.
1882	Habermann and Hönig.	Action of cupric hydrate upon sugars	Wien. Akad. Ber., (1882,) 657. Ch. Zeit., vi, 1050.
1882	Hesse	Anhydrous grape-sugar	Berl. Ber., xv., 2349. Ch. Zeit., vi, 1252.
1882	Hölzer	Sources of error in polarizing	Berl. Ber., xv, 1932. Dingl. J., ccxlvi, 345. Z. Anal. C., xxii, 237.
1882	Kiliani	Lactic acid from dextrose	Berl. Ber., xv, 136.
1882	Kiliani	Saccharone and saccharine	A. C. P., ccxviii, 361. Berl. Ber., xv, 701, 2953; xvi, 2294. Dingl. J., ccxlv, 191; ccxlvii, 435. Zeit. Anal. Ch., xxii, 267.

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Date.	Author.	Subject.	References.
1882	Lebaigne	Optical estimation of glucose	Rep. Pharm., xxxviii, 391. Ch. Zeit., vi, 1205. Wag. J. B., (1882,) 692.
1882	Leplay and Cuisinier	Preparation of maltose	Dingl. J., ccxlvii, 267.
1882	Lowitz	Discovery of grape-sugar	Sc. Amer., xlvii, 409, (Crell.)
1882	Marcano	Direct fermentation of starch	C. R., xcv, 856. J. Pharm., (5,) vii, 168. Ch. Zeit., vi, 1285.
1882	Moritz	End of Fehling's reaction in very dilute solutions.	Z. Anal. C., xxii, 43. Berl. Ber., xvi, 437.
1882	Müller, W	Preparation of grape-sugar by Neubauer's method.	J. Pr. Ch., (2,) xxvi, 78. Amer. Ch. J., iv, 296. Wag. J. B., (1882,) 690.
1882	Müller, W	Testing for sugar in urine	Pflüg. Arch., xxvii, 107, 86. Z. Anal. C., xxi, 608. Ch. News, xlii, 119.
1882	Nessler and Barth	Testing for potato-sugar in urine	Z. Anal. C., xxi, 53.
1882	Otto	Preparation of grape-sugar and titrating with Knapp's test.	J. Pr. Ch., (2,) xxvi, 87. Ch. N., xlvi, 208.
1882	Perrey	Origin of saccharine matter in plants	C. R., xciv, 1124.
1882	Robin	Sugar in urine	Monit. Scientif., July, 1882. Ch. News, xlvi, 78.
1882	Soxhlet	Saccharification of starch	Sc. Amer. Sup., xiii, 5378.
1882	Sidersky	Estimating invert sugar	Z. Ver. Rübenz., (1882,) 779. Ch. Zeit., vi, 1253.
1882	Wiley	Investigations on starch-sugar	Ch. News, xlvi, 175. Dingl. J., ccxlvii, 378. Ch. Zeit., vi, 1206. Wag. J. B., (1882,) 692.
1882	Wolff	Testing for starch-sugar in sirups	Pharm. Centrlb., xxiii, 491. Dingl. J., ccxlvii, 228. Z. Anal. C., xxii, 280.
1882	Zincke	Constitution of glucose and fruit-sugar	A. C. P., ccxvi, 318.
1883	Antweiler and Breidenbend.	Estimation of diabetic sugar by fermentation.	Pflüg. Arch., xxviii, 179. Z. Anal. C., xxii, 143. Ch. News, xlvii, 179.
1883	Bourquelot	Researches on physiological properties of maltose.	C. R. Le Genie Civil., iv, 82.
1883	Carles	Cane-sugar better than glucose for making wine.	J. Pharm., (5,) vii, 14. Ch. News, xlvii, 35.
1883	Casamajor	Simple test for glucose in sugar	Sc. Amer., xlviii, 217.
1883	Chittenden and Ely	Alkalinity and diastatic action of human saliva.	Am. Chem. J., iv, 329. Berl. Ber., xvi, 974.
1883	Eitner	No grape-sugar in leather	Gerberz., (1883,) 31. Dingl. J., ccxlviii, 218.
1883	Faulenbach	Estimation of grape-sugar and starch in food with Fehling's solution.	Z. Physiol. C., vii, 510. Berl. Ber., xvi, 2322.
1883	Flechsig	Cellulose sugar	Z. Physiol. C., vii, 523. Berl. Ber., xvi, 2508.
1883	Gladstone and Tribe	Action of light and heat on cane and invert sugars.	J. Ch. Soc., (1883,) 341. Berl. Ber., xvi, 2509.
1883	Haas	Comparison of Fehling's, Sachsse's, and optical methods.	Z. Anal. C., xxii, 215. Berl. Ber., xvi, 1112. Ch. News, xlvii, 247.
1883	Herzfeld	Maltose	A. C. P., ccxx, 206.
1883	Johnson, C. S.	Ammonia-cupric method	Ch. News, xlvii, 57.
1883	Keating	Salivary digestion of starch by infants	Med. News. Drug. Circ., (1883,) 172.
1883	Lagrange	Glucose and invert sugar precipitated by lead salts.	C. R., xcvii, 857. Berl. Ber., xvi, 2775. Ch. Zeit., (1883.)
1883	Von Mering	Is glucose wholesome?	Sc. Amer., xlviii, 161. Viertcljahr. Gesundheitspflege, (1882.)
1883	Müller-Thurgau	Transformation of starch into sugar at low temperature in plants.	Ann. Agronom. J. Pharm., (5,) vii, 508.
1883	Otto Lorenz	Manufacture of potato-starch	Pract. Mach. Constr., (1883.)
1883	Petzholdt	Diazo-benzol-sulpho-acid test for grape-sugar.	Berl. Klin. Wochensch., (1883,) No. 14. Z. Anal. C., xxii, 466.
1883	Salomon	Starch and its changes under the influence of organic and inorganic acids.	J. Pr. Ch., xxviii, 82. Berl. Ber., xvi, 2509. Ch. Zeit., vii, 1193.
1883	Scheibler	Saccharine	Berl. Ber., xiii, 2212.
1883	Sonnerat	Cupric solutions for estimating glucoses	J. Pharm., (5,) viii, 28.
1883	Soxhlet	Refining and crystallizing starch-sugar	Sc. Amer. Sup., xv, 5985.

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Date.	Author.	Subject.	References.
1883	Tollens	Action of dextrose towards ammonia-silver solutions.	Berl. Ber., xvi, 921.
1883	Scheibler	Formation of saccharine from glucoses	Berl. Ber., xvi, 2434.
1883	Urich	Inversion of saccharose	Berl. Ber., xvi, 762.
1883	Vivien	Estimation of glucose	Dingl. J., ccl, 133. Sucrerie Ind., xxi, 3. Berl. Ber., xvi, 2775. Sc. Amer., xlviii, 217.
1883	Zulkowsky	Estimating sugar	Ber. Oestr. Ch. Ges., (1883,) 39. Dingl. J., ccl, 133. Berl. Ber., xvi, 2775.
1883		Manufacture of glucose in America	Ch. Zeit., vii, 1212.

APPENDIX F.

PATENTS RELATING TO THE MANUFACTURE OF STARCH AND STARCH-SUGAR.

No.	Date.	Patentee.	Title.	Method.
12,846	May 8,1855	H. V. Duryea.....	Starch-rake.....	Specifications not printed.
22,789	Feb. 1,1859	W. Duryea.....	Making starch	Specifications not printed.
28,278	May 15,1860	C. S. Irwin.....	Cleansing starch	Specifications not printed.
40,693	Nov. 24,1863	T. Kingsford.....	Starch-machine	Specifications not printed.
42,358	Apr. 19,1864	W. Duryea	Removing starch.....	Specifications not printed.
42,727	May 10,1864	F. W. Gossling.....	Improved manufacture of sugar.	Soak the corn a week, crush it and soak again, wash with alkali, convert with sulphuric acid, heat with worm of lead pipe.
42,728	May 10,1864	F. W, Gossling.....	Making sugar.....	Specifications not printed.
43,047	June 7,1864	M. Thompson.....	Treating grain for distillation.	Specifications not printed.
49,012	July 25,1865	H. A. Tilden.....	Improvement in manufacture of sirup from corn.	Treats the entire grain with sulphuric acid at 220° F.
55,629	June 19,1866	H. I. Diessner.....	Improvement in making sirup from corn.	Adds barley-malt, sugar, and wheat-flour.
56,356	July 17,1866	John Briggs.....	Improved apparatus for preparing starch and size.	
58,824	Oct. 16,1866	A. H. Hirsh.....	Improvement in manufacture of sugar from corn.	Softens the corn with dilute acid at 170° F., to remove gluten; then crush, sieve, and wash with dilute ammonia. Convert with sulphuric acid; neutralize with sulphate of alumina.
60,370	Dec. 11,1866	T. Hawkes.....	Condensed extract of malt..	Evaporated *in vacuo*.
60,630	Dec. 18,1866	Leopold Hoff.....	Improved malt-extract.....	Uses decoction of fennel.
64,139	Apr. 23,1867	Narcisse Pigeon ...	Improvement in manufacture of starch-sugar.	Converts with 1 per cent. sulphuric acid at 300° F.
65,664	June 11,1867	J. J. Gilbert.....	Improvement in manufacture of starch.	
66,121	June 25,1867	C. H. Blanchard...	Improved machine for making starch, paste, size, &c.	
67,514	Aug. 6,1867	A. Erkenbrecher...	Improved starch-elevator...	
67,515	Aug. 6,1867	A. Erkenbrecher...	Improved starch-making apparatus.	
67,516	Aug. 6,1867	A. Erkenbrecher...	Improved starch-agitator...	
68,294	Aug. 27,1867	A. Erkenbrecher...	Improved apparatus for drying starch.	
68,374	Sept. 3,1867	Mason & Brant.....	Improved machine for stirring starch.	
73,259	Jan. 14,1868	J. A. Owens.....	Improved starch-making apparatus.	
78,320	May 26,1868	J. A. Owens.....	Improved starch-tray.....	
81,880	Sept. 8,1868	C. Gilbert.....	Improved starch-separator.	
87,758	Mar. 16,1869	Wm. Clough.....	Improvement in defecating saccharine fluids.	Uses ground sulphate of baryta, and coagulates by heat.
87,759	Mar. 16,1869	Wm. Clough.....	Improvement in refining and decolorizing saccharine liquids.	Hydrate of alumina and water-glass employed.
87,980	Mar. 16,1869	Sims & Hutchinson.	Improved mode of preparing grain for distillation.	Removes oils by carbon disulphide.
94,341	Aug. 31,1869	J. J. Ridge.....	Improved process and apparatus for treating flour and meal.	Farinaceous substances are roasted at 212° F. for six hours, and mixed with an alkaline or saccharine substance.
101,783	Apr. 12,1870	S. Stenberg.....	Manufacture of sugar and alcohol from lichens.	Boiling with dilute acids.
109,991	Dec. 6,1870	C. Delamarre.....	Sugar from sweet-potatoes..	Malted barley added to the paste, heated to 180° F., then to 220° F., and cold water added.
113,997	Apr. 25,1871	C. H. Fringes.....	Improvement in preparing and mashing grain.	Treated with dilute alkali, which is neutralized with HCl.

Patents relating to the manufacture of starch and starch-sugar—Continued.

No.	Date.	Patentee.	Title.	Method.
115,051	May 23, 1871	J. J. Grosheinz.....	Improvement in manufacture of glucose sirups and sugars.	Uses dilute hydrochloric or sulphuric acid, and neutralizes with soda, potash, magnesia, &c.
118,523	Aug. 29, 1871	W. Garton.....	Preparation of fermentable saccharine matters.	Neutralizes with finely-ground animal charcoal or phosphate of lime.
118,524	Aug. 29, 1871	W. Garton	Manufacture of invert sugar for brewing, &c.	Adds dilute sulphuric acid to saccharine juices, and heats to 160° or 212° F., then adds animal charcoal.
127,418	June 4, 1872	W. H. Keyt.....	Improvement in manufacture of glucose.	Converts starch at low temperature, (220° F.,) and neutralizes with lime.
135,904	Feb. 18, 1873	C. Gilbert.	Improvement in manufacture of starch.	
137,911	Apr. 15, 1873	C. Gilbert	Improvement in starch apparatus.	
137,911	Apr. 15, 1873	C. Gilbert	Improvement in starch-mill.	
140,141	June 24, 1873	T. Kingsford	Improvement in starch apparatus.	
140,141	Aug. 5, 1873	T. Kingsford.....	Improvement in starch apparatus.	
145,213	Dec. 2, 1873	T. Kingsford	Improvement in starch apparatus.	
145,846	Dec. 23, 1873	O. F. Cook	Improvement in processes of preparing grain for flour.	
156,802	Nov. 10, 1874	W. A. Lawrence...	Improvement in composition of hop-extract for flavoring beer.	Mix hop-extract, glycerine, grape-sugar, and cane-sugar.
159,837	Feb. 16, 1875	E. E. Pearse.....	Improvement in manufacture of grape-sugar.	Converting rice and other grain into glucose, or grape-sugar, by one operation in a vessel containing dilute sulphuric acid.
166,090	July 27, 1875	W. Garton	Improvement in manufacture of glucose.	Rice, &c., is converted by acid and heat, and, instead of neutralizing, the excess of acid is used to invert cane-sugar.
167,224	Aug. 31, 1875	L. Chiozza	Improvement in treating maize.	Immerses the grain in sulphurous acid before crushing and screening.
172,099	Jan. 11, 1876	E. E. Duryea.....	Improvement in drying starch.	
186,935	Feb. 6, 1877	S. H. Johnson.....	Improvement in manufacture of glucose.	"Permeable" grain made by treating with dilute hydrochloric acid; wash; drain; macerate with acid again, then submitted to the direct action of steam under pressure.
187,250	Feb. 13, 1877	Boomer & Randall.	Improvement in manufacture of malt sirups or extracts.	Fatty acids removed by alkali.
187,313	Feb. 13, 1877	H. R. Randall.....	Improvement in manufacture of malt sirups or extracts.	Washing ground grain at 180° F., then mixing it with malt at 158° to 160°.
187,747	Feb. 27, 1877	H. R. Randall.....	Improvement in saccharine composition sirup.	A mixture of uncrystallizable glucose with sucrose.
187,881	Feb. 27, 1877	A. Manbré.....	Improvement in apparatus and processes for manufacturing purified saccharine solutions.	Removes fatty matter by distilling it off after mixing with dilute acid.
191,942	June 12, 1877	R. d'Heureuse	Preparing mash.....	Uses a high pressure without raising the temperature so as to injure the diastase—say, 140° to 175° F.
195,718	Oct. 2, 1877	F. Melkersman	Improvement in drying and purifying starch by centrifugal action.	
198,192	Dec. 18, 1877	R. d'Heureuse	Process and apparatus for disintegrating cereals.	
198,474	Dec. 25, 1877	B. S. Toothill.....	Process for manufacture of sirups.	Mashing ground corn or other cereal with barley-malt.

Patents relating to the manufacture of starch and starch-sugar—Continued.

No.	Date.	Patentee.	Title.	Method.
202,832	Apr. 23,1878	T. Kingsford.....	Process and apparatus for drying starch.	
203,935	May 21,1878	Narcisse Pigeon...	Improvement in process for manufacturing glucose.	Adds diastase to the corn-mash at 125° F.; then heats to 185° F.; then cools to 152°, and adds more diastase.
210,496	Dec. 3,1878	J. Carmick.....	Improvement in malt-extracts.	Malt barley, wheat, and oats separately; mix; evaporate *in vacuo* at 120° F.
213,320	Mar. 18,1879	G. Burkhardt.....	Processes for manufacturing starch.	
214,910	Apr. 29,1879	L. G. Hezi.....	Improvement in starch compounds.	Adds sulphate of ammonia, sugar, and acetic acid.
218,020	July 29,1879	H. M. Hartshorn....	Improvement in processes for manufacturing glucose.	Corn is granulated dry, sifted, ground to meal, and converted by diastase or acid.
220,116	Sept. 30,1879	Behr & Humphrey	Extracting oil from the residuum of glucose.	The starch first removed leaves the fat in the residuum, which is extracted with bisulphide of carbon.
220,150	Sept. 30,1879	H. C. Humphrey...	Improvement in manufacture of glucose.	Direct treatment of the corn with an organic acid.
220,825	Oct. 21,1879	G. A. Gessner.....	Producing malt-extract.....	A heated extractive liquid percolates through the hot grain.
223,847	Jan. 27,1880	J. F. Gent.....	Prepared cereal.....	
226,398	Apr. 13,1880	C. Furbish.....	Process of manufacturing glucose.	The corn is cracked and hulled, the hulls and clippings removed, and the hard portion subjected to heat, water, and pressure. It is then converted by diastase or acid under pressure.
226,434	Apr. 13,1880	J. F. Wolff	Process of manufacturing glucose.	Currents of air or oxygen forced through the mass while mashing; boiling, and neutralizing.
230,991	Aug. 10,1880	L. J. Bennett.....	Process of obtaining the glutinous and starchy substances from Indian corn.	Beating or whipping off the glutinous portion or hull.
231,804	Aug. 31,1880	H. C. Humphrey....	Obtaining starch and glucose from corn.	Part of the starch is separated and sold, the remainder converted into glucose.
235,053	Nov. 30,1880	T. Gassaway.....	Manufacture of starch.....	
236,330	Jan. 4,1881	R. d'Heureuse	Manufacture of glucose.....	The corn, freed from hulls and germs, is steeped and the solution of gluten expelled in centrifugal machine. It is converted with acid, neutralized with lime, then oxalic acid and soda added.
241,202	May 10,1881	A. G. Fell	Manufacture of glucose.....	Corn treated with nitro-sulphuric acid at 195° F. to 214° F. It is boiled in vacuum-pans and sulphurous-acid gas introduced.
241,476	May 17,1881	F. Camus	Treating cereals to separate oily germs, flour, and starch.	
243,310	June 21,1881	C. Sheibler.....	Separating gypsum from solutions of starch-sugars.	The use of barium oxalate.
244,902	July 26,1881	S. H. Johnson.....	Production of saccharine substances containing little or no starch.	Dilute hydrochloric acid employed and steam at a pressure of 60 to 90 lbs., or water at 305° F.
248,313	Oct. 18,1881	F. Higel	Glucose from the cassava plant.	Converts with sulphuric acid and neutralizes with sea-shells.
248,904	Nov. 1,1881	Wilson & O'Reilly	Gum substitute.....	Starch is moistened with hydrochloric acid, dried and heated evenly, or roasted.

Patents relating to the manufacture of starch and starch-sugar—Continued.

No.	Date.	Patentee.	Title.	Method.
250,117	Nov. 29, 1881	Weber & Scovell...	Manufacture of glucose from seeds of sorghum, imphee, &c.	Uses sulphuric acid in open or closed converters.
Reissue 9,947.	Nov. 29, 1881	L. Chiozza.....	Process of treating maize....	Steeping in sulphurous acid before crushing it.
238,474	Mar. 1, 1881	C. O'Sullivan.....	Treatment of starchy substances and production of a substitute for malt in brewing, and called "dextrine maltose."	Starch treated with sulphuric acid, and the conversion stopped when there is 44 per cent. of glucose, as found by Fehling's method.
239,171	Mar. 22, 1881	T. A. & W. T. Jebb.	Obtaining starch from grain.	
240,651	Apr. 26, 1881	A. L. Bruce.....	Treatment of dextrine, maltose, &c., and apparatus.	Apparatus for drying the products, so that they can be pulverized when cold.
240,652	Apr. 26, 1881	A. L. Bruce.....	Machinery for treating dextrine, maltose, &c.	
240,796	Apr. 26, 1881	H. Williams.....	Process and apparatus for manufacturing grape-sugar, (to make it crystallize.)	Artificially cools and agitates the sirups after it leaves the vacuum-pan, then adds a creamy solution of grape-sugar.
240,907	May 3, 1881	T. A. & W. T. Jebb.	Apparatus for steeping grain.	
241,666	May 17, 1881	T. A. & W. T. Jebb.	Obtaining starch from Indian corn.	
241,903	May 24, 1881	Williams & Alberger.	Manufacturing crystallizable grape-sugar.	One per cent. of finely-powdered grape-sugar added.
242,207	May 31, 1881	Lyon & Taylor.....	Machine for pulverizing grape-sugar.	
Reissue 9,732.	May 31, 1881	J. A. Owens.....	Manufacture of starch.....	
242,439	June 7, 1881	A. P. Dubrunfaut..	Saccharification of amylaceous matters by malt.	Starch-paste treated with an exhausted infusion of malt at 122° F. for sixty or seventy hours. Oxydized malt infusions are more active.
243,024	June 14, 1881	E. Wilhelm.....	Starch-separator.....	
243,269	June 21, 1881	T. A. & W. T. Jebb.	Starch-table	
243,270	June 21, 1881	T. A. & W. T. Jebb.	Starch apparatus.....	
243,669	June 28, 1881	Williams & Alberger.	Process of manufacturing glucose from grain.	Cancelled. (See 246,262.)
245,340	Aug. 9, 1881	A. Behr.....	Apparatus for manufacturing starch-liquor.	
246,262	Aug. 23, 1881	Williams & Alberger.	Glucose from grain.....	At first only enough acid is used to produce soluble dextrine and coagulate glutenandalbumen; filter, then convert with acid; residue used as cattle-food.
Reissue 9,850.	Aug. 23, 1881	Williams & Alberger.	Process of manufacturing crystallizable grape-sugar.	The same as 241,903, above.
246,671	Sept. 6, 1881	R. W. Graves.....	Starch-table	
246,816	Sept. 6, 1881	Porion & Méhay...	Utilizing residua of the acid treatment of grain for manufacture of alcohol.	If the residues are fed to cattle, purify the hydrochloric acid and use pure carbonate of soda.
247,152	Sept. 20, 1881	A. Behr.....	Process of treating corn in the manufacture of starch, glucose, &c., from it.	It automatically separates the corn and water into three parts—germs alone, hulls, mealy part.
247,153	Sept. 20, 1881	A. Behr	Apparatus for the above.....	It automatically separates the corn and water into three parts—germs alone, hulls, mealy part.
247,288	Sept. 20, 1881	J. L. Alberger.....	Process of manufacturing sugar from corn.	Grain or meal treated with hot water and steam only until the starch is converted into a solution of soluble dextrine, filtering, converting with acid or malt-liquor.
247,433	Sept. 20, 1881	W. G. Taylor.....	Apparatus for siphoning starch-liquor.	

Patents relating to the manufacture of starch and starch-sugar—Continued.

No.	Date.	Patentee.	Title.	Method.
247,455	Sept. 20, 1881	Williams & Alberger.	Refining glucose, or grape-sugar.	Its bitter element is eliminated by fermenting it after saccharification.
247,957	Oct. 4, 1881	F. Soxhlet	Refining starch-sugar	The sirup mixed with ethyl or methyl alcohol and pulverized grape-sugar.
247,958	Oct. 4, 1881	F. Soxhlet	Refining and crystallizing starch-sugar, (anhydrous.)	Crystallizes a mixture of starch-sugar and wood-spirit at 30° to 35° C., (86° to 95° F.)
248,734	Oct. 25, 1881	R. W. Graves	Starch-table	
248,972	Nov. 1, 1881	Williams & Alberger.	Manufacturing glucose, or grape-sugar.	It is converted into dextrine and filtered before saccharification.
248,973	Nov. 1, 1881	Williams & Alberger.	Apparatus for starch or starch-sugar.	
249,056	Nov. 1, 1881	T. A. Jebb	Starch-separator	
250,084	Nov. 29, 1881	S. M. Lillie	Process of and apparatus for mixing glucose with cane-sugar.	A moist sugar is obtained by spraying a solution of grape-sugar on dry cane-sugar in the revolving machine, slacking its speed.
250,143	Nov. 29, 1881	R. W. Graves	Machine for reducing starch.	
250,333	Dec. 6, 1881	A. Behr	Manufacturing crystallized anhydride of grape-sugar from watery solution.	A mass containing about 15 per cent. of water is kept at 100° F. for 12 to 24 hours, then centrifugalled.
250,334	Dec. 6, 1881		Refining grape-sugar	See above.
250,333	Dec. 6, 1881	Behr & Humphrey	Manufacture of starch and sirup or sugar from corn.	The overflow from the starch-tables treated with acids to saccharify the starch.
250,362	Dec. 6, 1881	H. C. Humphrey	Method of settling starch-liquor.	
251,827	Jan. 3, 1882	G. Burkhardt	Method and apparatus for obtaining starch.	
251,887	Jan. 3, 1882	H. C. Humphrey	Treating maize in manufacture of beer, glucose, &c.	First makes soluble starch with acid, separates germs and hulls, then converts it.
253,337	Feb. 7, 1882	A. Atkinson	Machine for starch	
253,919	Feb. 21, 1882	Gresecke & Hamlin.	Process of manufacturing corn-sirup.	Heats a mixture of cane and grape sugar, and agitates it.
253,923	Feb. 21, 1882	H. Hamlin	Art of manufacturing starch.	
254,029	Feb. 21, 1882	C. Lautz	Starch-table	
254,063	Feb. 21, 1882	M. J. Stark	Starch-table	
254,157	Feb. 28, 1882	E. Roat	Apparatus for washing starch.	
254,158	Feb. 28, 1882	E. Roat	Starch-machinery	
254,159	Feb. 28, 1882	E. Roat	Apparatus for cooling sirups.	
254,359	Feb. 28, 1882	E. Roat	Apparatus for manufacturing starch.	
254,240	Feb. 28, 1882	Roat & Hamlin	Process and apparatus for treating starch refuse.	The wet material is subjected to pressure, disintegration, and heat, to prepare it for cattle-feed.
254,329	Feb. 28, 1882	W. T. Jebb	Method and apparatus for manufacturing distilled spirits.	Grain mashed with malt and fermented.
254,330	Feb. 28, 1882	W. T. Jebb	Distilled spirits from grain	
256,221	Apr. 11, 1882	T. A. & W. T. Jebb.		
256,315	Apr. 11, 1882	Graves & Heede	Starch-separator	
256,622	Apr. 18, 1882	A. Behr	Crystallized anhydrous grape-sugar.	A longer time allowed for crystallizing at 90° F.
256,623	Apr. 18, 1882	A. Behr	Crushed anhydrous grape-sugar.	
256,630	Apr. 18, 1882	W. T. Booth	Starch-separator	
256,809	Apr. 18, 1882	E. Roat	Crystallizing apparatus for grape-sugar.	
256,835	Apr. 25, 1882	H. Hamlin	Purifying glucose	Two concentrations, with intervening filtration.
257,930	May 16, 1882	E. Fox	Manufacture of glucose	Filters out gluten before saccharification; agitates with air.
257,959	May 16, 1882	Matthiessen & Behr.	Apparatus for emptying starch-tables.	
257,958	May 16, 1882	F. O. Matthiessen	Washing out starch-troughs.	

Patents relating to the manufacture of starch and starch-sugar—Continued.

No.	Date.	Patentee.	Title.	Method.
258,070	May 16, 1882	T. A. & W. T. Jebb.	Starch apparatus	
258,265	May 23, 1882	J. J. Toukin	Starch-settling tanks	
259,050	June 6, 1882	Roat, McKee & Hamlin.	Converter for starch into glucose.	
260,380	July 4, 1882	J. & F. Firmenich	Starch-washer	
260,853	July 11, 1882	J. Duff	Obtaining dextrine and saccharine matter from grains.	Grind, mash, regrind, separate hulls, then finish the conversion.
261,445	July 18, 1882	P. H. Grimm	Starch-separator	
264,688	Sept. 19, 1882	P. H. Grimm	Starch-separator	
266,136	Oct. 17, 1882	P. H. Grimm	Starch-separator	
263,030	Aug. 22, 1882	W. Duryea	Starch apparatus	Pressed, heated, ground, and then mixed with ground grain, for cattle-feed.
263,525	Aug. 29, 1882	W. T. Jebb	Treating starch-refuse	
263,958	Sept. 5, 1882	E. S. Renwick	Manufacture of starch	
264,037	Sept. 5, 1882	T. A. Jebb	Manufacture of dry grape-sugar.	Agitate and cool the liquid, and expose to air-currents.
264,222	Sept. 12, 1882	H. W. Bartol	Manufacture of glucose	Removes oils and gluten by soaking in acid or alkali at 90° to 120° F.
266,268		W. B. Brittingham.	Glucose from cactus	Uses diastase.
267,546	Nov. 14, 1882	G. Langa	Manufacture of dextrine, glucose, and grape-sugar.	Attacks starch with oxygenated glucose-liquid and phosphoric acid; neutralizes with saccharate of magnesia.
268,653	Dec. 5, 1882	A. G. Fell	Manufacture of glucose	Treats the grain with acids; neutralizes, and then treats with sulphurous acid under pressure.
269,717	Dec. 26, 1882	W. Robinson	Method of treating grape-sugar.	Breaks it up, and passes through the fragments a current of vapor capable of taking up the impurities.
269,779	Dec. 26, 1882	H. Endemann	Manufacture of glucose and grape-sugar.	Orthophosphoric acid acts on starch above 212° F.
270,042	Jan. 2, 1883	A. G. Fell	Manufacture of glucose	Purifies it by cooling the hot solution to precipitate the gluten, &c.
270,699	Jan. 16, 1883	W. Robinson	Method of crystallizing grape-sugar.	Melts the sugar, but arrests the process before completely dissolved, and adds 5 per cent. of water below 212° F., to form an emulsion, and lets it stand at low temperature.
276,334	Apr. 24, 1883	H. W. Bartol	Manufacture of glucose and grape-sugar.	It is converted by the dry process, without separating the starch from foreign matters; uses sulphurous acid, and filters the mass over charcoal.
277,320	May 8, 1883	C. C. Miller	Machine for cutting blocks of grape-sugar.	
278,392	May 29, 1883	J. H. Brookmire	Apparatus for mixing sugars.	
278,562	May 29, 1883	Landry & Langa	Methods and apparatus for converting amylaceous and ligneous substances into grape-sugar.	By using oxygenated chlorine.
279,354	June 12, 1883	J. W. Decastro	Converting starch into glucose.	Uses carbonic acid and steam under pressure.
280,045	June 26, 1883	T. P. Kingsford	Manufacture of dextrine, glucose, &c.	Soak in lime-water; grind; add sulphurous acid, then nitric acid, and finally steam-pressure.
285,067	Sept. 18, 1883	Polson & Harley	Manufacture of starch	
285,654	Sept. 25, 1883	T. Norton	Process for crystallized grape-sugar.	A concentrated solution is cooled almost to solidification, then melted, and permitted to cool and crystallize.
288,245	Nov. 15, 1883	H. J. Krebs	Manufacture of glucose	Exposing the grain to acidulated water in movable vessels.